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SEVENTH FRAMEWORK PROGRAMME

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European responses to climate change: deep emissions reductions and mainstreaming of mitigation and adaptation

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Report on integrated options for reducing risk/vulnerability (adaptation) that take account of mitigation

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Executive Summary

The aim of the RESPONSES project is to identify and assess options for mainstreaming climate change mitigation and adaptation into European Union directives and other policy instruments. The reduction of flood and drought risk can be an important part of an adaptation strategy, as well as contribute to climate change mitigation. This deliverable explores options for reducing flood and drought risk in EU agriculture and water policy with a specific focus on the Warta region of Poland. As stated in the RESPONSES DOW, Deliverable 4.3 will provide a "description of relevant non-climate policies and their implementation on risk/vulnerability (to flood and drought risk) of the Upper Warta". We also develop integrated flood and drought adaptation options that take account of mitigation. These options will be analyzed further in Deliverable 4.5, which provides a cost-benefit assessment of selected policy measures reducing flood and drought risk and thus contributing to adaptation and mitigation. It is hoped that these policy assessments will provide insights on guiding EU policies. Our research methods include a literature search and stakeholder interviews at the national, regional and local levels.

To meet our aims, in this deliverable we discuss and provide insights on the following questions:

- As an adaptation measure, what are the potential *agricultural and water management* measures for reducing flood and drought risk in the Warta region?
- How does the EU support, regulate and provide guidance for flood and drought risk reduction measures?
- How are the potential impacts of climate change on flood and drought risk taken into account in assessing these measures? How are the contributions of these measures on climate change mitigation accounted for?
- What measures are particularly robust for addressing climate-related drought and flood risks, and at the same time mitigating climate change, and how can they be assessed?

As an adaptation measure, what are the potential agricultural and water management measures for reducing flood and drought risk in the Warta region?

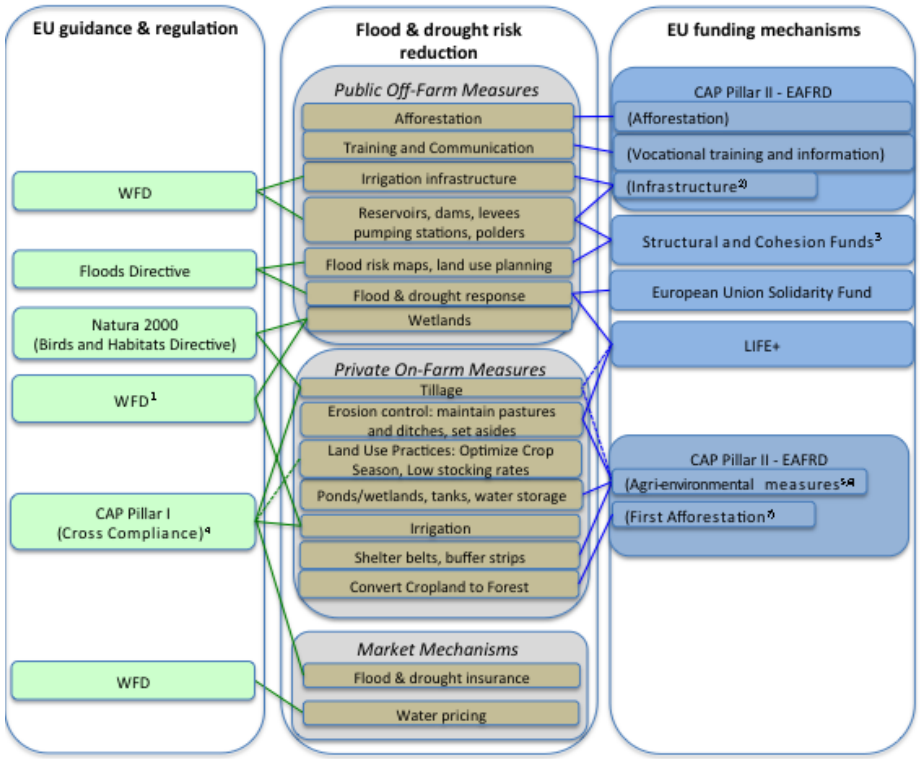
A large variety of agricultural and water management measures can reduce the risks of flood and drought in temperate climates such as that found in Poland, and thus contribute to climate change adaptation. We have identified over 50 measures classified as public "off-farm", private "on-farm" and "market" measures. Figure 1 shows those measures that are currently in place or topical in the Warta region of Poland. Of particular interest is the historical priority of investing in large reservoirs, primarily as a flood prevention measure, and the current interest in medium and small reservoirs, as well as other on-farm measures that retain water in the landscape, such as planting trees, for example, as shelter belts and changing tillage practices. On-farm measures can contribute (perhaps

significantly), not only to reducing drought and flood losses, but also to climate change mitigation, as well as other co-benefits like biodiversity.

How does the EU support, regulate and provide guidance for flood and drought risk reduction measures?

The EU has a strong portfolio of measures in place that are relevant for reducing the risks of flood and drought. As shown in Figure 1, these measures provide, on the one hand, guidance and regulation (i.e. *sticks*) and, on the other hand, they actually provide funding to farmers and public authorities for flood and drought adaptation activities (*carrots*) and thus support adaptation to climate change. With the exception of the Flood Directive, these measures are not targeted specifically to flood and drought risk management, nor are they targeted to climate change adaptation and mitigation; yet, in many ways they serve this purpose. The most powerful regulatory measures are found in the Water Framework Directive (WFD), which, for example, requires authorities to institute water pricing. The most powerful funding mechanisms are found in the Common Agricultural Policy (CAP) and the structural and cohesion funds that provide support for regional development. The WFD coupled with recent reforms of the CAP will take climate change adaptation and mitigation more directly into account.

Figure 1 EU funding and guidance for on- and off-farm measures for flood and drought risk reduction.



Notes: 1 – Oder River Basin Management Plan; 2 - EAFRD Article 30; 3 – European Regional Development Fund; 4 - CAP requires crop insurance, which is subsidized by national authorities; 5 – EAFRD Article 39, Scheme 9; 6 – AEP subsidizes very small (100 m2) ponds. 7 – EAFRD Articles 43,45. Acronyms: WFD = Water Framework Directive, CAP = Common Agricultural Policy, LIFE+ = Financial Instrument for the Environment, EAFRD = European Agricultural Fund for Rural Development. Lines indicate existing (solid line) and potential (dotted line) links.

The Water Framework Directive (WFD), and especially the Flood Directive (FD), provide strong signals for Member States to assess and manage flood risk, and prepare a drought risk management strategy. The structural and cohesion funds and the European Agricultural Fund for Rural Development (EAFRD) as part of the Common Agricultural Policy (CAP) are the largest sources for funding agricultural and water projects. A sizeable part of these funds have financed public off-farm projects, like reservoirs, levees and polders, which aim to reduce flood risk, but which may have fewer co-benefits with regard to climate change mitigation and the support of biodiversity than their on-farm counterparts. Consideration of these co-benefits is mandated or supported in EU policy documents, such as Natura 2000, LIFE+ and the Adaptation White Paper.

It should be noted that currently a number of EU policies, and their implementation by Polish authorities, provide disincentives for climate change adaptation and mitigation. Most notably, CAP's area farm payments, which subsidize arable land more than forested land, discourage such measures as shelter belts and micro-reservoirs (above 100 m3), both important for adaptation and mitigation, especially if they are interconnected in the landscape. The Polish policy of exempting surface waters used for irrigation from water pricing (thus offering public waters free of charge) also discourages farmers from investing in water retention measures, such as small reservoirs and conservation tillage practices. As a final example, while the EU requires extensive crop insurance, the Polish implementation of this requirement with sizeable public subsidies also lessens incentives for farmers to take on privately funded risk reduction measures.

With the latest CAP "health check", an important opportunity exists to finance smaller, on-farm measures that contribute to adaptation by retaining water in the landscape and thus reducing flood and drought risk, and also to mitigation by sequestering CO2 in soils and woodlands. The Health Check pays particular attention to the cereals market. It recommends that while community intervention should take into account the rising demand for cereals, they should also address the rising importance of bio-energy, which, when implemented as shelterbelts, can contribute to CO2 sequestration as well as boost biodiversity and runoff infiltration. Moreover, the Commission's proposed reforms to CAP will eliminate the disincentives deriving from area farm payments, and shift more funds to so-called 'green payments' with great potential for support for integrated and robust flood and drought risk management measures, like small reservoirs, afforestation and conservation tillage, that not only contribute to climate change adaptation but also to mitigation.

How are the potential impacts of climate change on flood and drought risk taken into account in assessing these measures? How are the contributions of these measures on climate change mitigation accounted for?

The Flood Directive and the Common Implementation Strategy (CIS) for the Water Framework Directive state that uncertainty related to climate change should be presented transparently in flood maps, and climate change scenarios included in ongoing initiatives and in planning processes. According to the EU's Climate Change & Water Guidance document, it is expected that climate change will be fully integrated into river basin management plans (RBMPs) for the 2nd and 3rd RBM cycles, ending in 2015 and 2021 respectively. In the RBMPs for the Vistula and Oder, it is stated that for the first planning cycle the foreseen climate

changes will be of very little importance to impacts for actions identified in the plans. This was reflected, for example, in the cost-benefit analysis (CBA) carried out for the Wielowieś Klasztorna reservoir, planned for completion in 2015, which did not take climate change into account. Moreover, this CBA did not consider the contribution of the reservoir to climate change mitigation.

While climate change is not considered relevant for the current planning period (until 2015) this does not mean it is not relevant for long-term investments, like levies or reservoirs that will outlive the planning period. Still, risk estimates that take account of climate change, and are robust for policy making, are still in their infancy (as shown by our estimates in Deliverable 4.2). In addition to climate change, other non-stationary pressures will be (even more) relevant for flood risk assessment. The EU has not issued communications that address these difficult assessment and policy hurdles. *In fact, at this time there are no specific strategic documents linking CAP to flood and drought risk management or adaptation practices at the national and local levels.*

Although many analyses have been carried out for large infrastructure projects, albeit not considering climate change, we have not identified analyses that examine on-farm measures for the purpose of retaining water. This is an important gap given that in many cases on-farm water retention measures have the co-benefit of sequestering CO2 and supporting biodiversity.

What measures are particularly robust for addressing climate-related drought and flood risks, and at the same time mitigating climate change, and how can they be assessed?

The recent report on climate extremes (SREX) by the Intergovernmental Panel on Climate Change (IPCC 2012) notes the difficulties of determining the contribution of climate change to current flood and drought risk, although experts expect significant changes in *future* drought and flood risk due to climate change in the coming decades (IPCC 2012). While most experts agree that countries should prepare for these future changes, the lack of current attribution and the uncertainties surrounding future risk scenarios contribute to the complexity of mainstreaming climate change into flood and drought policy.

Notably, with respect to floods, even the sign of the future change may be indeterminable at this time. Because of this uncertainty, it is important to explore solutions to the flood and drought problem that are robust in the sense of improving the current situation in the face of many different and uncertain futures. One such solution is increasing water retention in rural areas, which is important both for increased dry periods (droughts) and, because it lowers risk to urban areas, for increased wet periods (floods). In addition, water retention measures can have substantial co-benefits (and co-costs) with respect to climate mitigation.

The extent to which the Commission emphasizes on-farm water retention measures should depend to a large extent on their costs and benefits compared to off-farm water retention measures. We have identified four water retention measures for our continued analysis in Deliverable 4.5. These include the public construction of large reservoirs, the private construction of micro-scale reservoirs, and on-farm practices of afforestation (including shelterbelts) and conservation tillage. We choose these measures because of their potentially differential impact on climate change mitigation and biodiversity, and because the recent EU directives

could pave the way for switching national priorities from large scale reservoirs to smaller scale on-farm water retention measures. They represent important policy choices that characterize the current policy debate, and they are comparable in terms of their costs and benefits as measured by their effectiveness in retaining water in the landscape. Furthermore, they are not mutually exclusive, and a key policy question may be how to properly integrate these options to retain water effectively at different scales. However, more rigorous analysis will be needed to determine the costs and benefits of these different policy paths.

In sum, the WFD, FD and latest proposed CAP reforms have set the stage for funding, regulating and guiding agricultural/water policies, especially on-farm measures that promote "green" objectives and specifically adaptation and mitigation to climate change. Yet, there are surprisingly few analyses of on-farm measures that assess their benefits and costs. The objective of Deliverable 4.5 will be to evaluate two EU agricultural/water policy options that have been identified as particularly relevant for climate adaptation and mitigation in Poland and throughout many Member States. Both options are aimed primarily at retaining water in the landscape with the primary benefit of reducing flood and drought risks, but with secondary benefits and costs, including mitigation of climate change and impacts on biodiversity. The selected options include: (1) a continued policy of strong support for large reservoirs, and (2) increased and intensified support for on-farm water retention measures, including small reservoirs, afforestation and conservation tillage.

1 Introduction

The aim of the RESPONSES project is to identify and assess options for mainstreaming climate change mitigation and adaptation into European Union directives and other policy instruments. This deliverable (D 4.3) explores options for reducing flood and drought risk in EU agriculture and water policy with a specific focus on the Warta region of Poland, as well as how climate change is factored into these options. As stated in the RESPONSES DOW, Deliverable 4.3 will provide a "description of relevant non-climate policies and their implementation on risk/vulnerability (to flood and drought risk) of the Upper Warta".

The reduction of flood and drought risk can be an important part of an adaptation strategy, as well as contribute to climate change mitigation. However, the extent to which current flood and drought risk management contributes to climate change adaptation is not fully established. According to the recent IPCC report on climate extremes (SREX), experts expect significant changes in *future* drought and flood risk due to climate change in the coming decades (by 2050); however, there is only scant evidence that climate change is currently contributing to these risks (IPCC 2012). While most experts agree that countries should prepare for these future changes, the lack of current attribution and the uncertainties surrounding future risk scenarios contribute to the complexity of mainstreaming climate change into flood and drought policy.

Keeping in mind the uncertainties in climate attribution, the intent of this deliverable is to generate policy options in accordance with Task T4.4:

Task T4.4: Policy options generation: Evaluation of the role of relevant non-climate policies, including the Water Framework Directive (Directive 2000/60/EC), NATURA 2000 (Directive 92/43/EWG), the EU Solidarity Fund (EUSF) and the Common Agricultural Policy (CAP) and their implementation to manage climate risk and vulnerability.

We also develop integrated adaptation options that take account of mitigation. Our research methods include a literature search, stakeholder interviews at the national, regional and local levels, and a stakeholder workshop. A list of interviewees and their affiliations can be found in Appendix I; a list of participants in the stakeholder workshop can be found in Appendix II. A summary of the workshop will be provided in Deliverable 4.5.

This deliverable does not stand alone, but should be considered as an extension of Deliverable 4.2, which provides an "impact analysis of climate change on drought/flood risk, relevant non-climate policies and their implementation, and consequences for agriculture and ecosystems." Specifically, D 4.2 is framed as a "baseline" assessment of three adaptation and mitigation issue areas that are located within the water and agriculture intersection: floods, droughts and biomass production. In this report we focus exclusively on flood and drought risk in the Warta river basin. Because of the limited impact of bioenergy and biomass production on flood and drought risk (although there may be substantial impacts on food production, biodiversity and other areas of concern), we do not consider policy options related to bioenergy. The production of bioenergy has a higher carbon footprint than primary energy sources (70 to 400 times); yet, it is often

no higher than the crops it replaces (Fernando et al. 2010). If the food crops are not replaced, but displaced to another location, the footprint does increase substantially as compared to using other energy sources.

In this deliverable, we address the following questions:

- As an adaptation measure, what are the potential *agricultural and water management* measures for reducing flood and drought risk in the Warta region?
- How does the EU fund, regulate and provide guidance for these measures?
- How are the potential impacts of climate change on flood and drought risk taken into account in assessing these measures? How are the contributions of these measures on climate change mitigation accounted for?
- What measures are particularly robust for addressing climate-related drought and flood risks, **and at the same time mitigating climate change,** and how can they be assessed?

Climate change is only expected to (significantly) impact flood and drought risk in several decades (by 2050); yet the IPCC emphasizes that climate change is expected to affect the functioning and operation of existing water infrastructure, including hydropower, structural flood defenses, drainage and irrigation systems. Current water management practices might also not be robust enough to cope with the impacts of climate change and climate variability on water supply reliability, flood risk, agriculture, energy and ecosystems (OECD 2010b). A key issue is whether failure to change current practices and infrastructure soon enough keeps society locked on a path that will make it difficult or impossible to improve our coping and adaptive capacities fast enough when climatic change does become significant and serious.

In this deliverable we flag investments that will be potentially influenced by climate change, for example, the construction of reservoirs, and report on experience and methods for taking account of climate change in the investment decision. With regard to floods, the SREX report noted the difficulties of determining even the sign of the change, and for this reason we explore robust solutions to the flood and drought problem. One robust solution is increasing water retention in rural areas, which is important both for increased dry periods (droughts) and, because it lowers risk to urban areas, for increased wet periods (floods). After identifying options for the region, we turn to asking how the EU does and can mainstream support for these options in its policy instruments, most importantly, the Common Agricultural Policy (CAP), the Water Framework Directive (WFD), the Flood Directive (FD), the European Union Solidarity Fund (EUSF) and the structural and cohesion funds.

Our discussion proceeds as follows: In the next section, we discuss the range of agriculture and water policy options for reducing flood and drought risk as identified in the literature and suggested by stakeholders. These include public off-farm, private on-farm and market measures. In Section 3, we identify ways in which the EU is supporting, regulating and/or guiding the implementation of these measures. We turn our attention specifically to integrated options for adapting to climate change by reducing drought and flood risk, and at the same time contributing to climate change mitigation. In so doing, we select four on-

farm and off-farm prototypical measures that increase water retention in the landscape; therefore, each is robust to uncertainties in flood and drought risk. These include: (1) publicly constructed large-scale reservoirs, (2) privately constructed on-farm micro-reservoirs, (3) on-farm afforestation and specifically shelter belts, and (4) conservation tillage practices. We have chosen these measures since they represent an important policy choice between public "off-farm" measures and private "on-farm" measures that characterizes the current policy debate, and they are comparable in terms of their costs and benefits as measured by their effectiveness in retaining water in the landscape.

In the follow-up deliverable (D 4.5) we examine, and quantify to the extent possible, the costs and benefits of these measures, where possible taking account of climate change and climate change mitigation, and examine whether the EU is taking a balanced approach in its support. Only with this information on the tradeoffs between the off- and on-farm measures is it possible to suggest options for the EU in targeting its CAP, WFD and other policies to reducing flood and drought risk, and for mainstreaming climate change mitigation and adaptation.

2 Measures to reduce flood and drought risk in the Warta basin

The Warta River in west-central Poland is the largest tributary of the Oder, which forms part of the boundary between Poland and Germany. The largest city in the region is Poznań, the capital city of Wielkopolska Voivodeship (province or region), with a population of approximately 600,000 (for a more detailed description of this region, see Deliverable 4.2). In terms of water availability per capita, Poland is one of the most water-poor European countries, and precipitation and runoff in the Warta River basin are below even the national average (Blomquist et al. 2005). At the same time, this region is subject to extensive flooding that threatens Poznan and other urban areas.

As discussed in Deliverable 4.2, a large variety of *agricultural and water management measures* can reduce the risks of flood and drought in temperate climates such as that found in Poland. These measures, which are shown in Table 2.1, can be classified as **public "off-farm" measures** that are financed and constructed by the public authorities, and as **private "on-farm" measures** that are implemented at the farm level. Also included are **"market" measures** that are put into place by public authorities or private enterprises, and which can provide incentives for risk reduction measures. While some measures address only flood or only drought risk, those measures that support the management of water dynamics allow mitigation of both flood and drought, marked 'F' or 'D' in the 'Hazard' column. With some exceptions (e.g., desalination) these measures are relevant for the Warta river basin, and many are in place. Important for our discussion, a number of these measures, or extensions of these measures, are on the current policy agenda at the regional, national and even European scales. We have marked (in italics) the most discussed measures, both because of their potential or controversy, as identified from a literature survey supplemented by interviews with relevant stakeholders, including farmers, water managers, agriculture advisors, and scientists specializing in water, agriculture and ecology.

Many of the measures shown in Table 2.1 are already prioritized, implemented or planned by farmers or the responsible authorities. The Polish Water Law Act (2001) specifies the planning, controlling and monitoring of the performance of measures to protect against floods and droughts, where priorities include: regulating construction on floodplains, developing technical flood protection measures, developing maps of flood hazard zones, identifying anthropogenic pressures on water resources and assessment of their impacts on surface and ground waters, setting-up actions and instruments leading to improvements in water quality. The Water Act confirms what is observed historically, that most policy measures in Poland have invoked 'hard' technical approaches to managing water, e.g. river defense engineering, including dams, levees, and reservoirs (Tonderski 2004). Increasingly experts are examining non-structural 'soft' approaches for water retention, such as forests, shelter belts and conservation tillage (Gleick 2003), which may be cost-effective alternatives with lower ecological impacts. This is a question that will be examined in Deliverable 4.5, where cost-benefit analyses of selected measures will be provided.

Table 2.1: Off-farm, on-farm and market measures for managing drought and flood risk in the Warta region

Response type	Measures/examples	H
Public Off-Farm Measures		
Water retention with storage schemes	**Upland water retention** - Ditches, *wetlands, ponds* *- Afforestation* **Water storage areas (floodplain/river)** - *Reservoirs*, polders, wash lands *- Dams*	D D
Managing river water conveyance	**Containing water volume in river channel** *- Levees, embankments, retaining walls, channelization* **Conveying water to increase farm water access** -Pumping stations, aqueducts, weirs, diversions, canals **River re-naturalization to restore natural water dynamics**	F D
Managing water demand /supply	**Increase efficiency of available water use** - Water recycling, desalinization, regulation, education, technology **Increase water governance capacity** -Education, institution building	D D

Response type	Measures/examples	H
	Decrease Demand *- water pricing*	D
Managing flood impacts	**Spatial planning and regulation** - Zoning, flood-proofing buildings, flood risk maps **Enhancing capacity to cope with extreme events** *- Public Insurance, government relief and reconstruction*, early warning, emergency planning, infrastructure, education, disaster preparedness	F D D
Private On-Farm Measures		
Water retention by managing runoff and increasing infiltration	**Arable land use practices** - Optimize crop season - Water harvesting, supplemental irrigation, soil cover/mulches - Extensification, set-aside areas, convert arable land to grassland - Machine management: Low tire pressures, avoiding wet conditions **Livestock land practices** - Lower stocking rates, restrict grazing season, maintain pastures **Tillage Practices and erosion control** *- Conservation tillage, no tillage, contour farming, furrow cropping* **Water storage**	D D

Response type	Measures/examples	H
	- *Ponds*, bunds, tanks **Buffer Strips and buffering zones** *-Contour grass strips, hedges, shelter belts, bunds, riparian buffer strips*	D D D
Managing farmland water conveyance	**Management of hill slope connectivity** - Blockage/opening of farm ditches **Channel maintenance and/or realignment** - Maintenance of farm ditches, dredging **Managing Water distribution** - *Irrigation infrastructure*	D D D
Reducing exposur	**Spatial planning to restrict construction in flood-prone areas**	F

Response type	Measures/examples	H
e and vulnera bility	**Reinforcement of critical equipment and infrastructure** - Flood-proofing buildings, securing equipment **Enhancing capacity to cope with extreme events** - Private insurance	F D

Legend: Measures most under discussion are marked in italics. The hazard each measure can address is marked either by a D (Drought) or an F (Flood) or both. Source: adapted from Morris et al. 2010; OECD 2010a; stakeholder views

Another important legislation affecting the Warta river basin is the "Programme for the Odra River – 2006" (PFOR 2006), established in 2001 by the Polish parliament to be implemented between 2002-2016 with expenditures totaling some 2.5 billion euro. PFOR 2006 sets out a strategy of modernization of the water system of the Odra river region, of which the Warta is a component basin. The programme aims to build a system of integrated water management for the basin, incorporating the needs of flood protection, the preparation of preventive spatial development plans, the protection of water purity, natural and cultural environment, transport, as well as general economic and consumption needs. Under PFOR 2006 tasks related to the following areas are undertaken: 1) the construction of passive (usually structural "hard") and active (usually non-structural "soft") flood protection systems, 2) the protection of the natural environment and water purity, 3) flood recovery, 4) preventive land management and re-naturalization of ecosystems, 5) the increase of wooded areas, 6) the maintenance and development of inland navigation, and 7) and the utilization of rivers for power generation.

2.1 Public measures (off farm)

In this section, we describe the main off-farm measures in the Warta river basin according to their current status, plans, and potential as a current or future policy option.

2.1.1 Water Management Infrastructure

The historical and legislative emphasis in Poland on engineered structural measures for flood and drought risk management is reflected in the Wielkopolskie Voivodship, where large sections of the rivers are protected by levees, embankments, retaining walls and small dams. The infrastructure in place in 2007 is listed in Table 2.2.

Table 2.2: Water Management Infrastructure in Wielkopolska Voivodship (status as of 01.01.2007)

Type		Extent/ amount
Natural rivers	km	6200
Canals	km	878
Levees	km	765
Embankments	object	444
Pumping stations	object	49
Reservoirs	object	31
Dams	object	1 497
Aqueducts	object	13
Communication infrastr.	object	819
Retaining Walls	object	327
Pipelines	km	55

Source: Wielkopolskie Amelioration Management and Water Facilities Board (WZMiUW) in Poznan

Despite this portfolio of risk management measures, floods and droughts remain a threat, in part because of the insufficient condition of Warta's infrastructure, which warrants restoration and modernization. According to the management authority for flood and drought protection infrastructure (Wielkopolskie Amelioration Management and Water Facilities Board 2012) the quality of dikes and channels is far from satisfactory. Despite years of restoration efforts, the embankments, for example, do not provide full protection, possibly because of the heterogeneous composition of their construction materials. In addition, embankments can be undercut since the underlying ground is weak (Tonderski 2004).

The Strategy for Wielkopolskie Voiviodship incorporates plans for the following water infrastructure for years 2002-2015:

- Construction of 170 ha of drainage and land reclamation systems,

- Regulation of 25% of existing natural rivers,
- Reconstruction and modernization of almost 50% of dikes, and
- Rebuilding of about 8% of embankment structures and 8% of pumping stations.

Investment in infrastructure during the period 2002-2006 amounted to about 28 million euro and by 2015 is planned at the level of about 125 million euro. Annually in Wielkopolskie about 250 km of levees undergo maintenance, but it appears that their deterioration rate is faster, placing the integrity of the levees in doubt over the long-term.

2.1.2 Reservoirs

Poland is committed to increasing its water retention capacity, which currently stands at a level of about 6%, compared to several neighboring countries where the level is around 10-12%. The strategy is to increase reservoir storage capacity at three different scales, which we define as follows:

Large reservoirs: 10 to 200 million cubic meters

Mid-sized reservoirs (river valley and lakes): 500,000 to 10 million cubic meters

Small (streams and ponds): Less than 500,000 cubic meters.

Poland

The total volume of reservoirs in Poland is estimated to be 3.26 billion m3, including 0.72 billion m3 of flood reserve. Most of this capacity is provided by 40 large reservoirs in Poland of a volume higher than 10 million m3, including 11 reservoirs of a volume higher than 100 million m3 (BBF 2003).

According to some experts (BBF 2003), to reduce the risk of floods to an acceptable level, Poland would require a water retention volume three times higher. Flood security could also be improved by reconstruction of 1000 km of dykes, regulation of 4000 km of rivers and constructing 0.4 billion m3 of polders (BBF 2003).

Wielkopolska region

The construction of *reservoirs* that serve both flood and drought protection is a major and topical policy option in the Wielkopolska region, where officially some 31 reservoirs are considered the prime water retention instruments by management (Table 2.2). However, regional water management options are actually far more diverse, storing water at three scales across Wielkopolska. Currently three large reservoirs ((Jeziorsko, Jezioro Pakoskie, and Jezioro Porajskie) and some 67 mid-sized reservoirs provide 95% of the region's water storage capacity. The remaining eight percent is provided by some 336 micro-scale ponds. As a whole, reservoirs are 140 ha on average, ranging in size from less than one ha and up to 1124 ha, and together they provide a total storage capacity of about 338 million cubic meters (Table 2.3). This constitutes some 8% of Poland's national surface water storage capacity, which is mostly provided by large reservoirs, and as such it constitutes only half (6 vs. 12%) of the capacity to

retain surface runoff that has been achieved in some neighboring states (Ministry of Economy, Work and Social Policy 2003 and cited in BBF 2003). Such reservoirs are especially important for those parts of the basin that have few lakes (Amelioration and Water Facilities Board 2007).

During the critical months of November to March, the main flood protection for the region's principal city, Poznań, is provided by a combination of the Jeziorsko reservoir (capacity 203 million m^3) and the natural flooding capacity of two upstream valleys (Blomquist et al. 2005). As shown on Table 2.3, another 110 million cubic meters is provided by mid-sized reservoirs constructed in river valleys and to stabilize lakes; 81 million cubic meters of water retention capacity is provided by 62 medium-sized reservoirs (average volume 1.3 million cubic meters) that cover some 4900 ha in river valleys, and some 33 million cubic meters storage capacity is provided by 48 reservoirs created with dams to stabilize lakes. Approximately 9 million cubic meters storage capacity is provided by dams placed on streams to regulate outflow, and some 12 million cubic meters of water retention capacity is provided by some 284 micro-reservoirs or ponds (average volume 42 thousand cubic meters) that cover some 630 ha (Table 2.3 after BIPROWODMEL 2005).

Table 2.3 – Water storage capacity (in 1000 m3) for reservoirs in Wielkopolska Voivodship

	Reservoir Type		
	Large (10-200 million m3)	**Mid-sized** (0.5 – 10 million m3)	**Small (micro)** (less than 0.5 million m3)
Number	3	67	561
Total capacity (thousand m3)	316,000 (70.1%)	111,702 (24.7%)	23,665 (5.2%)
Average size (hectares)	2005.2	97.6	7.1
Average volume (thousand m3)	105,630	1667	42.03
STD DEV	90,080	1204	80.8

	Reservoir Type		
MIN	24,900	520	0.7
MAX	202,800	5800	486

Source: IIASA based on statistics from the *Bureau of Water Amelioration Projects and Environment Engineering (2005)*

In addition, the Wielowieś Klasztorna reservoir is currently under construction and planned for completion in 2015. With a dam height of nine meters, it has an expected retention capacity of 48.8 million m^3 over an area of 20 km^2. This will increase retention capacity about 10 percent or less, depending on the total contributions (data still not available) of reservoir storage capacity in Lubuskie Voivodship that lies in the Warta river basin. At first glance the massive capacity of the one major reservoir, Jeziorsko, appears to totally dominate the relative contributions of reservoirs at the mid- and micro-scale ranges. To match Jeziorsko's storage capacity would require 122 mid-sized reservoirs or 4833 micro-sized reservoirs. From the perspective of policy maker or a decision maker a macro-scale reservoir provides an enormous increase in floodwater storage.

However, valuing reservoirs solely on the basis of total flood volume stored ignores many other important costs and benefits. For instance, in comparison with small reservoirs and ponds, large reservoirs may be less effective at slowing the speed and volume of the flood crest, and, in addition, small reservoirs may be better suited for supplying irrigation water, cooling field micro-climates, and providing habitat for amphibious, aquatic and migratory bird species. Finally, depending on where they are constructed, they may result in less deforestation. Assessing the benefits and costs of large reservoirs versus other means of increasing water retention will be the task of Deliverable 4.5.

2.1.2.1 Stakeholder Views

In interviews stakeholders from the region agreed that although droughts are the most pressing problem, the most robust solution is to increase retention of water to address both droughts *and* floods. Water retention increases water availability in times of drought and slows runoff during flood events. Stakeholders indicated that Poland should follow other EU countries and strive to achieve at least 15% of retention of yearly overland flow. Retention capacity could be increased in the Warta basin also by diverting flood waters to the Golina Polder, even though development pressure since 1980 has diminished its primary retention capacity of 200 million m^3 (Malinger and Przedwojski 2007). Stakeholders agree that big reservoirs and polders are indispensable in dealing with low-probability high damage events, but small and micro reservoirs (natural or artificially created) are extremely important for reducing the impact of more frequent, less extreme flood and drought events. This was expressed by a participant at the RESPONSES workshop, an economist researching flood insurance in Poland, who stated that small reservoirs "…can also be important for retaining water and influencing the

micro-climate, etc., in areas located far from the river and adapting to more frequent events, most importantly in places where there is no impact of the Warta river itself." (Dubel, 2012a) In an interview (12 April 2012), Stefan Jankowiak, a farmer, concluded "… it may be easier and more effective for farmers to build small reservoirs privately, as publicly constructed reservoirs frequently confront long delays." (Dubel 2012a; Dubel 2012 b)

2.1.3 Re-naturalization of wetlands

The Warta basin is known for its Lake District, which embraces 1,428 lakes with a joint surface area of 435 km^2, or roughly 13% of the total Lake District area (Ramsar 2005). Lakes and other wetlands are ecologically significant areas. Those that have been lost or degraded can be re-naturalized or restored to their natural state. Restoration projects are usually located in regulated river beds, drained mires and peat lands, as well as in ecologically degraded lake catchment areas. Chiemlewski and Krogulec (2003) report on ten projects that have been carried out in central Poland. These projects not only reduce the risks of floods and droughts (by increasing retention area) but also increase habitat and biodiversity.

Rather than re-naturalization, it appears that the Wielkopolskie Voiviodship plans for about 25% of existing natural rivers to be regulated or their regulation reconstructed, modernized or improved.

2.1.3.1 Stakeholder Views

Regional water managers and administrators broadly recognize the importance of wetlands, first for their beneficial functions for retaining water and stabilizing the microclimate around agricultural fields, as well as their ecosystems services. However, wetlands are currently seen as, to quote the statement resulting from the workshop sessions"…having comparatively less benefit than ponds and other types of water retention options, especially in case of drought, as the water from wetlands cannot be diverted for irrigation." (Dubel 2012b)

2.1.4 Afforestation

More than a quarter of the Wielkopolska Voivodeship is covered by forests (see Figure 2.1), but forest cover is unevenly distributed in the region, ranging from 50% forest cover in the northwestern part of the country (Czarnków-Trzcianka County) to 10% cover in the eastern part (Koło and Słupca Counties). This pattern reflects a 200-year trend of removing infertile, sandy soil areas and heathlands from cultivation by planting forest, a process that has been reinforced recently by the increasing differential between agricultural input cost and produce prices following the transition to capital markets (Mizgajski 2002). The Noteć Forest, which lies at the fork of the Warta and Noteć rivers, is the largest dense forest complex. It sprawls over some 130,000 ha in a strip that is approximately 28 km wide and 100 km long (Ministry of Environment 2009). However, the basin has very little unmanaged habitat, which provides a range of ecosystem services. Nature reserves cover only 0.18 % of the basin territory (Mizgajski 2002).

Figure 2.1: Land use cover in the Warta river basin. Green areas represent forest cover (adapted from Tonderski 2004)

The principles of preserving, protecting and expanding forest resources in ways integrated with other components of the environment and economy are specified in the Forest Act of 1991. These principles balance environmental and social benefits with resource-related benefits. Currently, several laws provide the foundations of afforestation in Poland. First, the government approved in 1995 and updated in 2003 the National Programme for the Augmentation of Forest Cover (NPAFC). *The modified NPAFC provides for an increase of the formally accepted afforestation area to 680,000 ha in the years 2001 to 2020* and has led to verification of existing afforestation preferences across Poland. Pursuant to the National Forest Policy, the main objective of the NPAFC is to increase the country's afforestation to 30% in 2020 and to 33% in 2050 and to provide optimum spatial and temporal afforestation distribution, along with establishing ecological and economic preferences together with completion measures. These policy changes have reduced clear cuts, and, hence, runoff, and have doubled the rate of afforestation over the past decade as well as the growth of protective areas, e.g. from 22.5% to 47.5% by 2006 (Mederski et al. 2009). For the past 13 years, over 200,000 land parcels of different ownership status have been afforested under the framework of the NPAFC (Ministry of Environment 2009).

Measures to build or re-establish forest on agricultural land are authorized under Polish law through the Act of 8 June 2001 on Agricultural Land Intended for Afforestation. Most afforestation is carried out by the State Forests National Forest Holding Company, which manages 78% (ca. 470 million ha) of forests in Poland (Dzikowska et al. 2006). Forests in national parks and forests owned by local authorities and the State Treasury amount to 4% of the total forest area. The remaining 17% are private forests. The dominant role of the state in the forest ownership is peculiar to Poland and generally uncommon across the European Union. *A further incentive for afforestation arose in 2004 when a farmland afforestation support system was introduced within the framework of the Rural Development Plan (RDP),* funded within CAP from the European Agricultural Fund for Rural Development (EAFRD). *With 80% financial support*

provided by the EU and 20% from Polish funds, tens of thousands of hectares of farmland were afforested between 2006 and 2008 in conjunction with large-scale educational campaigns on afforestation for farmers (Ministry of Environment 2009).

Dzikowska et al. (2006) note that afforestation rates might well increase should policy reform close the gap between afforestation and agricultural subsidies and increase educational campaigns to raise the ecological awareness of farmers. At this writing, the CAP area-based payments to farmers are proportionally higher for arable land compared to payments for forest land that already exists. Based on the IACS system, there are basic area payments (173 € annually per cultivated hectare in 2011) and additional payments to specific kinds of production, e.g. wheat, beetroots, tobacco, potatoes, fruits and vegetables, etc. Note that incentives or payments are only available if land use is changed from arable land to forest land, but no support is available if a land parcel is already covered by forest. The Rural Development Programme 2007-2013 provides farmers with payments for planting and maintaining forests, but maintenance funding is only available for newly planted forests (Department of Social Communication 2012). Foresters and farmers can calculate their options under different subsidy schemes at the following website: http://www.agror.pl/pl/kalkulator_doplat.php. A sample calculation for Polish farmers shows that converting to forest from arable land will decrease CAP area payments significantly.

In Poland, from 1988 to 1993 afforestation averaged 3.9 thousand hectares each year, and from 1994 to 2004 it rose to 10.8 thousand hectares. Starting from 2005 this figure declined, and in 2010 there were only 7 thousand hectares of afforestation. Wielkopolska experienced a decrease of forest cover between 1989 and 1995. However, from 1995 to 2005 afforestation resulted in net annual gain of some 1416 hectares. Forest expansion occurred in areas with the highest forest cover in the northwest and east, where forest expansion in some communes, e.g. Okonek and Jastrowie, was double the regional average of 3990 hectares (Łowicki 2008).

2.1.4.1 Stakeholder Views

At the RESPONSES workshop on "Adaptation to flood and drought risk in the Warta water region: the role of the European Union," participants highlighted afforestation as one of the measures that is least frequently applied in the Warta catchment, but a measure with great promise. They indicated multiple benefits from afforestation, including the increase in rainfall of 5 mm per 1% increase in forest area (A. Kędziora cited in Dubel 2012a) of forest area, increase in water retention capacity of land, increase in the minimum water flow during times of water stress, slowing flood flows/waves, production of oxygen, CO2 sequestration, and restricting of soil erosion, among others. According to regional stakeholders, the barriers to afforestation in the region include the regional priority given to agricultural development, the ineffective and inflexible regulation of afforestation by a centralized state plan, the insufficient amount of space designated by municipalities for reforestation, the difference in subsidy levels between arable land (which receives more subsidies) and forest land, and finally that income from forest areas is delayed by a few decades.

2.2 Private measures (on farm)

In this section, we describe the main on-farm measures in the Warta region describing their current status, plans, and potential as a policy option.

2.2.1 Conservation tillage for sustainable soil cultivation

The threat of wind erosion to Wielkopolska's light soils is long recognized (Czarnowski 1956; Wilusz 1957), and this, aggravated by the historically intensive agricultural production, has increased drought risk by contributing, among other things, to a net loss (- 60 mm) in the region's water balance (Czajka et al. 2010 p. 48). This is roughly equivalent to a 10% loss of precipitation. Minimizing tillage can lower the impacts of wind erosion, and, hence, evapotranspiration that contributes to relative water scarcity.

Tillage is a set of practices to prepare the soil bed for seeding by mechanically working the soil to loosen it, remove weeds, to mix in fertilizers and residues into the soil, and shape the soil into rows for crop plants and furrows for irrigation. This helps productivity in a number of ways that include: loosening and aerating the top soil layers to facilitate the crop planting, mixing the harvest residue, e.g. organic matter (humus), and nutrients evenly throughout the soil, and drying the soil before seeding. However, tillage's short-term benefits can be undercut by a range of long-term effects that include, first and most prominently, erosion, but also compaction and hardening of the soil that reduces the capacity of the soil to allow surface water runoff to sink into the ground (infiltration rate) and move to the groundwater layer (percolation rate). As a result frequent and intense tillage practices result in higher and higher runoff rates that increase soil erosion and contribute to flood hazard downstream in the catchment. It also can raise farming expenses through increasing amounts of energy and fertilizers to prepare soil for planting because it progressively loses its structure (tilth and soil aggregates) and nutrient content. The resulting soil compaction can, in conjunction with intensive use of agro-chemicals, drastically reduce the biodiversity and functioning of soil flora and fauna and decrease water treatment and, eventually, the quality of downstream surface and ground waters (Wikipedia 2012).

To counter these latter negative effects, practices have been developed that range from no- or zero-tillage to "conservation" tillage. The former aims for 100 percent vegetation cover prior to seeding and involves costly investments in new equipment, e.g. seed drills, to plant seeds in soil already occupied by the roots of existing ground cover plants. The latter, conservation tillage, is designed to leave a minimum of 30% of crop residue on the soil surface (roughly 1,100 kg/ha) of small grain residue on the surface during the critical soil erosion period. This slows water movement, which reduces the amount of soil erosion, and increases the amount of organic material both above and below ground, thereby *enhancing carbon storage* and water absorption and retention in the soil itself. Conservation tillage systems also benefit farmers by reducing fuel consumption and soil compaction. By reducing the number of times that heavy farm equipment travels over a field, farmers realize significant savings in fuel and labor. These practices have become quite wide-spread around the globe. As of 2009, zero- or no-tillage tillage was used on about 26 500 000 ha of all cropland in the United States, half the area used for seeding in Canada (Statistics Canada 2011), and has increased

world-wide from 45 million hectare in 1999 to 111 million hectares in 2009 (Derpsch et al. 2010). In Europe, two nations rank in the global top-20 in terms of implementing no-till management: Spain (650 000 ha) and France (200 000 ha) (Derpsch et al. 2010). However, no-till practices have yet to become widespread in Poland. One regional expert in soil science (Weber 2012) estimates that no-till is practiced on less than 1% of agricultural land under cultivation in Poland

2.2.1.1Stakeholder Views

The "no- or conservation-tillage" measures were rated higher than afforestation by the Warta basin stakeholders as underutilized, beneficial practices. That is, they are infrequently applied in the Warta catchment, but are measures that should be applied more frequently. It is seen as a currently uncommon, but promising practice that can impact flood and drought adaptation. The benefits from a no-tillage agro-technique, as viewed by the stakeholders, include: increase of agricultural yields, more stable yields, higher soil retention, increase of decay in the soil (fertilizer for future crops), increase of CO2 sequestration (of about 36 Mg CO2/ha), increase of biodiversity (especially soil organisms), increased biologic activity of the soil as well as saving fuel and man-month costs, and an increase of jobs in equipment production. The most important barrier related to region-wide application of no-tillage, as viewed by the stakeholders, is tradition. Polish farmers have traditionally tilled their land, and believe that plowing results in high yields. Other barriers listed by the stakeholders include: lack of education of farmers, the long process of changing attitudes and equipment, poor transfer of knowledge (lack of appropriate research projects), the traditional stereotypes in science, and lack of studies on the use of fertilizers in no-tillage farming.

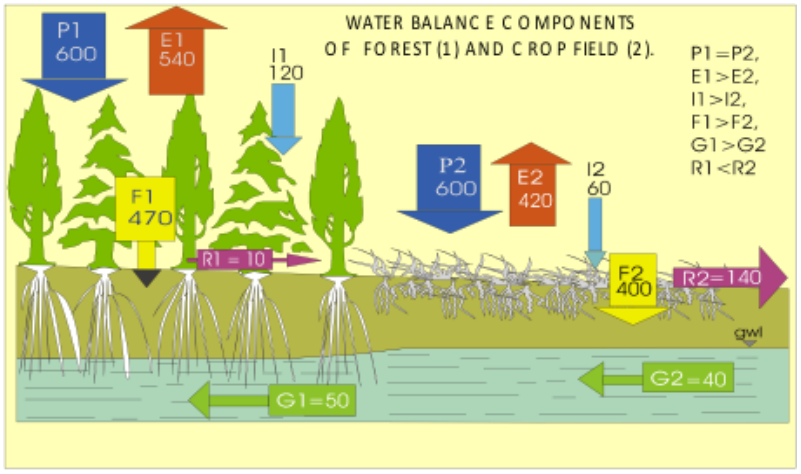
Many of the benefits sought in reducing tillage can also be achieved by creating and/or maintaining pastures. This practice sustains a near continuous ground cover of grass and related herb species found in meadows, provided that over-grazing does not reduce vegetative protection to the extent that runoff can amplify soil erosion. On the other hand, failure to mow or graze can result in pasture loss due to encroachment by trees and shrubs. In countries such as Slovakia, where grassland biodiversity is relatively high for Europe, such encroachment is a source of concern for biodiversity management. A further consideration is what land cover or land use best enhances ecosystem services in a particular landscape, especially with regard to topography. In mountainous regions, overexpansion of grasslands can reduce the rates of rainfall interception surface water infiltration and percolation, which re-forestation can restore, thereby reducing flood risk. Such reforestation efforts currently are directed in alpine regions of Austria by the *Gebietswasserhaushalt* Department of the *BFW Institut Für Naturgefahren und Waldgrenzregionen* in Innsbrück, Austria, to reverse excessive expansion of ski slopes or grassy alpine meadows that have removed too much forest cover, increasing runoff rates and, hence, flood risk (Markart et al. 2006). However, in the flatter topography of lowland river floodplains, wet pastures and meadows can provide sustainable income from grazing cows and swine while providing sufficient groundcover to resist erosion in flood events and providing some measure of water processing to reduce nutrient loading from runoff. These latter benefits are applicable to the relatively flat landscape of the Warta River basin.

2.2.2 Shelterbelts, buffer strips

Shelterbelts are linear landscape structures composed primarily of trees and shrubs that are often intentionally planted to line the margins of roads, agricultural fields and waterways. In the Turew region of the Warta basin, shelterbelts have been planted and cultivated since the 1820s, introduced from England by Dezydery Chłapowski, a prominent regional land owner. In Poland, shelterbelts consist of false acacia (*Robinia pseudo-acacia*), poplars (*Populus* spp.), oaks (*Quercus* spp.), pines (*Pinus* spp.), spruces (*Picea* spp.) and a small number of other tree species and shrubs (Ryszkowski and K□dziora 1987).

While shelterbelts exist on the margins of agricultural areas, their net spatial impact is far larger, extending into the fields themselves. Shelterbelts provide enough vertical structure to lower wind speed by 35-40% on the intervening agricultural fields with the following benefits: increasing relative air humidity, decreasing potential evaporation of crops, increasing snow depth, and reducing the melting rate of snow in spring. In combination these increase the percolation rate by 300 m3 per ha in areas covered with shelterbelts compared to open areas (Zalewski and Wagner-Lotkowska 2004: 137 – 153). Of particular interest with regarding to coping with climate change impacts such as increasing frequency and length of hot, dry weather episodes, shelterbelts buffer temperature extremes, e.g. heat waves, cooling the crop field microclimate by increasing the evapo-transpiration rates above that observed in meadows (+22%), row crop fields such as rapeseed (+31%), beets (+34%), wheat (+40%), and bare fields (+76%) (Ryszkowski and K□dziora 1987). These advantages are realized because, relative to agricultural fields, shelterbelts increase evaporation to enhance cooling and boost infiltration and interception to slow runoff (Figure 2.2)

Figure 2.2. Cross-section of tree shelterbelt and adjacent agricultural field illustrating how they influence various components of surface and groundwater hydrology (precipitation (P), Evaporation (E), Interception (I), Infiltration (F), Groundwater runoff (G) and Surface Runoff (R).



Source: Ryszkowski,and K□dziora (2002)

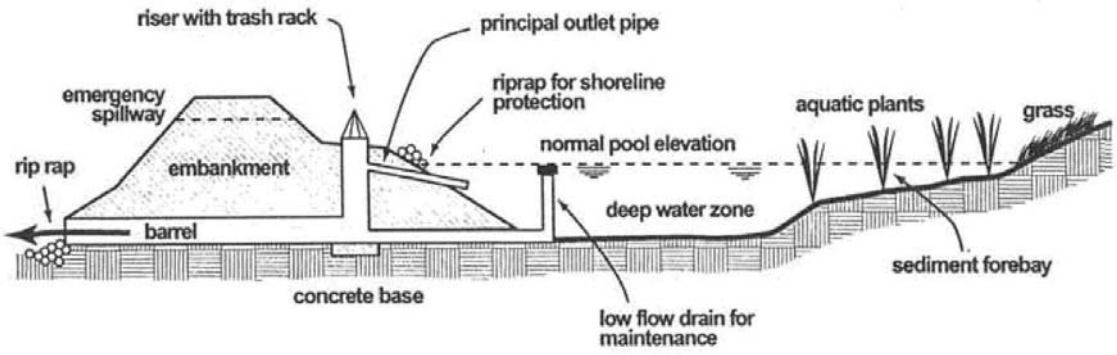
2.2.2.1 Stakeholder Views

Shelterbelts were discussed by the stakeholders during the RESPONSES project workshop as one of the most promising on-farm water retention measures. While shelterbelts are being planted in the Warta catchment, workshop participants agreed that this measure could be intensified. They mentioned benefits including: preventing wind erosion, increase of agricultural yields nearby the strips, positive impact on microclimate, increased sequestration of CO2 in wood biomass, amelioration of water balance, reduction of nitrogen, phosphorus loads on surface water quality, source of wood/biomass, a fivefold increase in biodiversity because shelterbelts provide a haven for small animals and insects, a more aesthetically pleasing landscape, a positive impact on bees and increase in agricultural yields, and enhanced opportunities for recreation. The most debatable costs of shelterbelts concerned the impacts of shelterbelts on the yields from agricultural production.

2.2.3 Small/micro reservoirs (ponds)

Reservoirs are one type of constructed aquatic/wetland ecosystem designed to contain storm water or rain run-off from the surrounding drainage area that would otherwise flow into other areas. Retention ponds are micro-scale reservoirs that permanently or perennially store water (wet ponds) with a variably flooded perimeter of aquatic plants that retain and treat storm run-off, thus improving water quality. Run-off is retained in the pond's wetland margins long enough to allow settlement of particles and biological treatment of dissolved pollutants (SEPA 2012). Currently, more than 561 such small-scale retention ponds exist in the Warta basin providing storage capacity for about 23.7 million cubic meters of runoff (see Table 2.3, section 2.1.2).

Figure 2.3: Storm water retention pond design, horizontal view



Source: Clemson University Cooperative Extension Service (2012)

2.2.3.1 *Stakeholder views*

Stakeholders viewed small/micro reservoirs (ponds) similarly to shelter belts as a solution that it is quite frequently applied in the Warta catchment, but still could be applied more frequently. With relatively low environmental costs, many

benefits were attributed by stakeholders to ponds, such as: wildlife habitat, increase of retention in the catchment, increase of biodiversity, positive impacts on microclimate, possibility of irrigation and water reserve in case of fire, increase of groundwater level leading to higher agricultural yields, integration of local community – pond construction near a village pulls public together and increases the attractiveness of the area. Due to economies of scale, storage of water is more expensive in a pond compared to a large or medium reservoir. Yet, the environmental costs of storing an equivalent amount of water with multiple ponds are much lower than if stored in a medium or large reservoir, provided that the multiple ponds are not in a chain along the river but instead are located higher in the catchment. This is because the key variable related to ecosystem services in rivers is minimum flow, i.e. the river must sustain a certain minimum flow rate at certain minimum depths to sustain the species that provide ecosystem services. Dams interrupt a river's length, which can cause a river to lose its functionality, that is, it can become a series of pools with decreased flow. Therefore, fewer dams allow more flow along a river length, and that mandates for fewer, larger-scale reservoirs. However, if more small-scale reservoirs, e.g. ponds, are placed higher in the landscape on farms and in forests, then the need to construct water storage capacity on the river is reduced. This suggests a combination of fewer large-scale reservoirs on the major river branches combined with more small-scale reservoirs to retard and store water higher in the catchment near the zones of water demand for agriculture.

The environmental, as well as flood and drought adaptation, benefits of many small ponds in the landscape are highly valued by the stakeholders. Stakeholders mentioned that the solution could be more frequently applied if provided available subsidies. CAP subsidies for farmers are calculated based on cultivated land and not acreage devoted to a pond. At the same time, the CAP area payments are providing some limited subsidies for ponds less than 100 m2 in area in the amount of 178 EURO per ha per year. At the RESPONSES Workshop (31.05.2012) stakeholders discussed the costs and benefits of ponds. Besides construction and maintenance costs they mentioned "mowing slopes to prevent overgrowth of plants, sediment clogging sewage treatment facilities, designating and maintaining buffer zones, loss of area for agricultural land use and quick eutrophication processes" as costs. However, they saw many benefits from ponds, such as: "wildlife habitat, increase of retention in the catchment, increase of biodiversity, positive impacts on microclimate, possibility of irrigation and water reserve in case of fire, increase of groundwater level leading to higher agricultural yields, integration of local community – pond construction near village pulls public together, increased attractiveness of the area" (Dubel 2012b). Ponds were seen as an adaptation solution quite frequently applied in the Warta basin, but worth applying more frequently. (Dubel 2012b) In the discussion it was mentioned that "…subsidies for farmers are to an area and not to a pond, therefore it is not an incentive for creating ponds" (Dubel 2012b).

2.3 Market measures

In addition to the on- and off-farm measures for reducing flood and drought risk, the government and private market (often working together) can design and implement market measures that provide incentives for risk management. As relevant to the Warta basin, these include water pricing and hazard insurance policies.

2.3.1 Water pricing

Water pricing is promoted by the EU Water Framework Directive as a potentially effective drought protection measure. As related to agriculture in Poland, water rights are defined through a public allocation system of permits. Extraction of surface and/or ground water below the level of 5 m^3 per day is free of charge. Water usage that totals more than 5 m^3/day is classified as the "special use of waters" and requires a water law authorization. However, according to the Environmental Protection Law some specific types of water abstractions are free of charge. They are: fish rearing and fish farming, irrigation (by surface water) and the operation of heat pumps and geothermal energy, if the water returned is of the same quantity and at least quality (concerning groundwater) (see Arcadis 2011). Water is delivered by water companies or individually by farmers, as in the rural areas only 25% of population (a 25-fold increase from1995) is connected to water pipes and sewage treatment systems (GUS Statistical Yearbook 2008).

Payments for water usage are designed as a system of mixed tariffs including: fixed charges, volumetric charges and a per hectare flat rate charge. In contradiction to the goals set out in the WFD, there is less than 100% cost recovery of Operation and Maintenance and Capital Costs for surface water delivered on-farm (OECD 2010b).

2.3.1.1 *Stakeholder views*

In interviews, scientists from the Institute for Agricultural and Forest Environment (IAFE) view the water-pricing instrument rather negatively – according to one scientist, "as a sign of helplessness on the part of the authorities". They indicated that water pricing is a good instrument against water pollution, limiting wastewater discharges, but not necessarily for drought adaptation. The connection between drought and water pricing was not evident to stakeholders, probably because irrigation, where water pricing would have the greatest impact, is rather limited in the Warta region.

2.3.2 Hazard insurance

As with water pricing, hazard insurance (if premiums are set in accordance to risk) places a price on risk (e.g., locating a house or farm equipment in hazard prone areas), and for this reason it can give important signals for reducing these risks. In Poland, crop and property insurance covering natural disasters is not broadly subscribed, owing in part to the historical expectation that the national government will provide post-disaster compensation. The acceptance of personal responsibility for disaster damages, and, hence, prevention measures like insurance, is only slowly developing. Moreover, insurers have become increasingly reluctant to offer flood and drought cover, or are limiting the cover offered (e.g. Hajnosz and Sidorowicz 2011; Kubica 2012).

2.3.2.1 Crop insurance

Multi-hazard crop insurance in Poland is offered by three commercial insurers, and highly subsidized by the central government. The typical contract provides protection

against frost and drought, but flood can also be included (it is generally offered as a part of property insurance). Property insurance, also offered by private insurers, is relevant to agricultural risk management policy, not only to protect agricultural infrastructure, but also to protect "downstream" urban areas. Property insurance is voluntary and rates are increasingly set according to risk (Dubel A. 2007).

In the agricultural sector, existing commercial flood risk premiums for multi-hazard cover can be as high as 11% of insured value at risk, and, for orchards up to 10-12% of insured value at risk (Dziennik Gazeta Prawna 17.05.2011). According to Polish law (Law on insurance of agricultural production and farm animals, 2008) farmers are required to insure at least 50% of their agricultural production against floods and droughts if they apply for EU agricultural subsidies. The premiums are 50% subsidized by the central government if the insurance premium is not higher than 6% of the insured amount. In practice, however, only about 10-12% of Polish farmers insure, and mainly the large farmers according to the President of Agricultural Insurance Commission in the Polish Insurers Chamber (about 25% of crops are insured) (Dziennik Gazeta Prawna 17.05.2011). There are small fines (two euro/ha) in terms of reductions in CAP direct payments for farmers who fail to purchase required insurance, but these fines are not enforced (Dziennik Gazeta Prawna 17.05.2011). The motivation is further reduced since in the case of a flood or other natural disaster, farmers anticipate payments from the central budget. There are plans for increased subsidization of crop insurance with support from the EU.

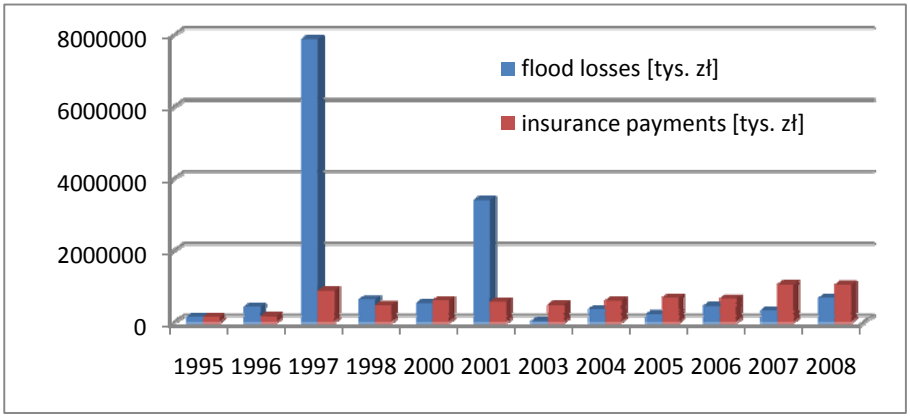
The result is that in 2010 about 7% of farmers and 4.4 million hectares or 32% of arable land were insured (Dziennik Gazeta Prawna, 21.10.2012). We do not have insurance figures specific to the Warta basin; yet, since Wielkopolska has larger farms than many other parts of Poland we would expect a higher than average crop insurance penetration.

Because of the low penetration rate of agricultural insurance, the Ministry of Agriculture is discussing a higher subsidy of 65% of premium, where the subsidy will be co-financed by national and EU CAP budgets (from the 10% discretionary fund as part of direct farm payments). The 2013 CAP reform encourages increased insurance. The higher subsidies will be implemented already in 2012 if the Commission approves.

2.3.2.2 Property insurance

Turning to property insurance, as shown in Figure 2.4, flood claims have amounted to only a small percentage of losses during years of major flood disasters (1997 and 2001). Although attitudes are changing, Poles count on state support for post-disaster assistance, and partly for this reason they do not take adequate protection themselves, even with regard to insurance. At the same time insurers' knowledge about risk is improving, and they are becoming more reluctant to offer coverage in high-risk areas, also as they perceive climate change as an additional driver of risk. As will be discussed in the next section, the Flood Directive is requiring extensive risk assessments in the Warta basin and throughout risk areas in Poland, taking account of climate change.

Figure 2.4: Flood losses in Poland (blue) compared to all natural disasters related insurance payments in years 1995-2008.



Source: GUS [Polish National Statistical Office] Statistical Yearbooks 1996-2009

To counter these problems, the government is considering a national program with mandatory property insurance against flood and other perils. An alternative is proposed by the opposition to create a "Fund for Helping Natural Catastrophes' Victims", which would be financed from the state budget and managed by the President. In fact, reforms have been debated since 2000, and in 2007 a special expert group coordinated by the Ministry of Internal Affairs and Administration (MSWiA) began work on developing a law on catastrophe insurance. The working group includes the Polish Chamber of Insurers (PIU), legal entities and an ombudsman of insured. A major issue being discussed is whether the system should be mandatory, which would relieve the national government from its traditional role of compensating farmers after major national disasters. (Mandatory agricultural insurance existed after World War 2.) Another issue in the debate is the extent of public subsidies. Some have estimated that a highly subsidized system would be less costly than current government post-disaster compensation (for example, in 2000, this compensation amounted to roughly 70 million Euros) (Dziennik Gazeta Prawna, 21.10.2010). Catastrophe credits (private bank loans subsidized by the government, where subsidies are higher for farmers who have insured at least 50% of their production), are available for relief and reconstruction where damages occurred due to drought, hailstorm, rainfall, frost, flood, storm, fire due to lightning or landslide. The responsible agency in 2010 is the Agency of Restructuring and Modernization of Agriculture (ARiMR))

Subsidized insurance has its critics. From the standpoint of climate change adaptation, there is concern that subsidized insurance will, by distorting the risk price, reduce incentives to take preventive measures.

The role of the government in a hazard insurance program is only one of many issues that need addressing before such a program can be implemented in Poland. The issues most relevant to this discussion include:

- Identifying risks taking account of climate, population and other anticipated future changes;

- Resolving the question of who should be responsible for losses, private individuals or the government, and particularly for the poor inhabitants of high-risk areas?

- Insuring public infrastructure.

2.3.2.3 Stakeholder views

In interviews, regional stakeholders (farmers, water managers) consider insurance as an important adaptation instrument helping people to cope and recover in case of natural disaster. However, stakeholders, especially farmers managing large areas, rate existing insurance cover as minimal and inadequate, as well as too expensive and overly complicated by many amendments. Proposed improvements included simplifying the existing schemes, e.g. insurance could pay out when a farmer's average income per ha falls sufficiently below a regional income level averaged over multiple years. The payment would compensate losses up to the multi-year average income. Not surprisingly, farmers preferred insurance subsidized by the state. Stakeholders also suggested establishing a mutual insurance fund within producer groups, because commercial insurance is becoming increasingly expensive.

2.4 Summary and stakeholder views

In summary, the Warta basin has extensive structural flood and drought measures in place, and planned investments will focus on their maintenance and the construction of additional reservoirs. Other "soft" measures, including afforestation, wetlands, on-farm ponds and farm practices, such as no-tillage techniques, appear less well financed, especially in the case of low- or no-tillage techniques, but are in discussion in the Warta region. Water pricing and subsidized hazard insurance are in place, yet with possibly significant reforms for the future.

The most frequently mentioned solution to flood and drought problems was measures that increase water retention in the landscape. In considering how to adapt to floods and droughts, stakeholders representing a diversity of institutions and responsibilities debated how to prioritize between large and small hydro-technical measures, e.g. major reservoirs, polders and ponds. *The debate led to a tentative consensus that there is high added value from 'on-farm' measures, such as ponds, agro-technical practices and shelterbelts.* These on-farm measures are particularly beneficial in times of water stress for areas with no direct link to a large river, such as Warta. They are less effective in the case of low-probability, high impact river floods, when large-scale hydro-technical measures may be necessary. Stakeholders outside the administration also pointed out that plans and programs should be realized in a thoughtful and systematic way, i.e. plans that integrate measures at different scales are needed.

Farmers, in particular, held the view that the government should develop plans to protect them against natural disasters and should support them better financially. Moreover, they feel that EU funds should support a diversity of adaptation measures that integrate the functioning of large, medium and micro (on-farm) reservoirs. However, concerning local, on-farm measures, the view was that it is easier and more effective to build small/micro reservoirs privately since the

record shows that the public sector encounters long delays and can be ineffective. Farmers also suggested that large reservoirs be managed by public institutions, and small/micro measures be managed by farmers, but financially supported by public money. In summary, stakeholders welcomed subsidies to better support effective adaptation measures, such as water management measures at different scales, as well as subsidies to support hazard insurance.

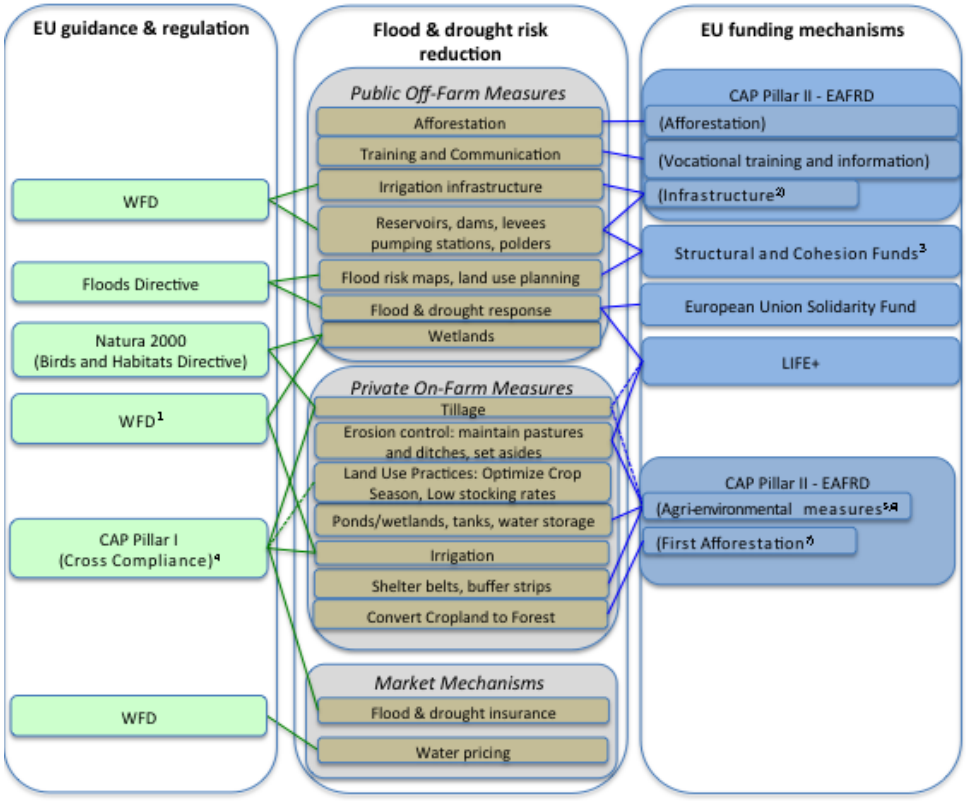
3 EU policies for managing flood and drought risk in the Warta region

In this section, we discuss EU policies – deliverables, regulations, guidelines - which are relevant to the off- and on-farm and market measures for managing flood and drought risk in the Warta region as discussed above. This discussion builds on the full description of measures in Deliverable 4.2, where we examined the **EU Common Agriculture Policy (CAP), the EU Water Framework Directive (WFD) and its daughter directives, the EU Floods Directive (FD) and the EU Water Scarcity and Droughts Strategy, and finally the EU Solidarity Fund**. These policies and directives, combined with the **Structural Fund and Cohesion Funds**, provide the most important legal instruments and funding mechanisms for managing flood and drought risk in the Warta region, and promoting climate change adaptation in the water and agricultural sectors. In Poland, EU policies and their accompanying funding mechanisms are the main drivers for setting and implementing environmental goals as well as for climate change adaptation and mitigation actions.

In contrast to Table 2.1, which includes all measures for managing flood and drought risk in Poland, Fig. 3.1 lists only those on-farm, off-farm and market measures that are currently in place or under consideration in the Warta region. Fig. 3.1 also organizes these measures in accordance with the relevant EU support mechanisms, which can take the form of funding mechanisms or regulations through EU directives, as well as guidance documents. The EU directives/regulations include foremost the CAP (Pillars 1 and 2) and the WFD/FD. We also mention the European Union Solidarity Fund (EUSF), the Structural Fund and Cohesion Funds, and EU initiative LIFE+ where relevant. Finally, we include the EU White Paper on Adaptation, which cautions against the overuse of structural defense measures, which because of their environmental impacts can lead to mal-adaptation.

What is most striking from Fig. 3.1 is the comprehensive EU policy landscape relevant to flood and drought risk management in the Upper Warta. With only a few exceptions, our identified portfolio of flood and drought risk management measures are funded or regulated by the CAP, WFD/FD and other EU policies.

Figure 3.1 - EU guidance, regulation and funding as applied for flood and drought risk reduction in the Warta region of Poland.



Notes: 1 – Oder River Basin Management Plan; 2 - EAFRD Article 30; 3 – European Regional Development Fund; 4 - CAP requires crop insurance, which is subsidized by national authorities; 5 – EAFRD Article 39, Scheme 9; 6 – AEP subsidizes very small (100 m2) ponds. 7 – EAFRD Articles 43,45. Acronyms: WFD = Water Framework Directive, CAP = Common Agricultural Policy, LIFE+ = Financial Instrument for the Environment, EAFRD = European Agricultural Fund for Rural Development. Lines indicate existing (solid line) and potential (dotted line) links.

The EU support mechanisms can be divided into two categories: The first are "*carrots*" in the form of payments to farmers, regional bodies and local authorities for taking on these measures. The Structural and Cohesion funds, e.g. the European Development Fund (EDF) and the European Regional Development Fund (ERDF), the CAP area payments and the EU Agricultural Fund for Regional Development (EAFRD) administered under the CAP, its Agri-Environmental Measures (AEM) and the European Union Solidarity Fund (EUSF) all provide funding for measures taken by farmers or governments, or in the case of the EUSF, for post-disaster reconstruction (see the right-hand column of Fig. 3.1). Life+ provides funding mainly for pilot projects. The second category is made up of "*sticks*" or required measures (and in some cases sanctions for not taking them). These include the WFD, FD, the requirements for agricultural insurance and for cross compliance in CAP.

Table 3.1 shows the main Polish and Wielkopolska policy instruments that serve to operationalize the EU policies shown in Figure 3.1. Table 3.1 can thus be viewed as connecting policy on the ground with policy at the EU level. Of course, there are many layers of planning, prioritizing and administering in between. In Deliverable 4.2 we detailed the institutional complexity of water and agricultural policy in Poland.

Table 3.1: Major Polish laws and regulations and funds that operationalize EU policy in Poland and the Warta basin (funding levels indicated in italics).

Jurisdictional Level		
EU	Poland	Regional (Wielkopolskie Voivodship)
Structural (ERDF and ESF) and Cohesion Funds *€67 billion for Poland (2007-13)*	-Programme for 'Infrastructure and Environment' *€ 556.8 million from EU* Operational Programme Innovative Economy (financed from the European Fund for Regional Development	-Regional Operational Programme for Wielkopolskie 2007–2013
CAP Pillar 1 (area farm payments – EAGF) Pillar 2 (rural development - EAFRD) *€13.2 billion (2007-13)* Agri-Environmental Measures (AEM) LIFE + (1)	-Strategy for Rural, Agricultural and Fishery Sustainable Development for 2011-2020 -Code of Good Agricultural Practice -Legal Act on Agricultural Insurance, Production and Farm Animals -Rural Development Plan 2007 – 2013 -Rural Development Programme for 2007-2013 -National Fund for Environmental Protection and Water Management -Nature Conservation Law Act	-Strategy of Wielkopolska Region Development till 2020 -Strategy for Rural Development and Agriculture 2007-2013 -Programme of Environmental Protection for a Voivodship -Regional Fund for Environmental Protection and Water Management
WFD	-Water Law Act -Environmental Law Act -National Water Management Strategy 2030 -Water–Environmental Programme for Poland	-River Basin Management Plan for Oder River -Strategy of Wielkopolska Region Development till 2020
Flood Directive	-Water Law Act -National Water Management Strategy 2030 -Operational Programme Innovative Economy	- -Strategy of Wielkopolska Region Development till 2020 - -Environmental Protection Programme

Jurisdictional Level		
EU	Poland	Regional (Wielkopolskie Voivodship)
	(financed from the European Fund for Regional Development) (2)	for Wielkopolskie - Assessment of the state of Flood Protection of Wielkopolskie Viovodship (2010) - Programme of small retention of water in Wielkopolskie Voivodship (2005) - Programme for preventive flood protection in the Odra river basin with special attention to the Warta river basin and the Szczecin lagoon – Odra Region - Program for Oder 2006 - National Strategy for Regional Development - Local (community) spatial plans (including flood hazard zones art. 84 Water Law Act)
Birds and habitats Directives (Natura 2000 network) LIFE +	-Natural Environment Protection Law with executive acts -Environmental Impact Assessment and access to the information about environment Law	-Management plans [*in Polish* Plany Zadań Ochronnych (PZO) and Plany Ochrony (PO)] developed for each Natura 2000 site
White Paper on Adaptation	-Legal Act on Spatial Planning and Management -Strategy for Adaptation to Climate Change for Poland	

Notes: 1 - LIFE+ is not part of CAP, but it is related in that it supports demonstration projects with similar goals as agri-environmental schemes. It concerns nature protection projects, e.g. it supports Natura 2000 and AEM. 2 - the Operational Programme is part of the

Structural Funds, however it also finances requirements of the Flood Directive to make the flood risk maps.

3.1 White Paper on climate change adaptation

Recently, the European Commission (2009) presented a White Paper (WP) laying out a European framework for action to improve Europe's resilience to climate change. The WP emphasized the need to integrate adaptation into all key European policies, including agriculture and water. Complementing the White Paper, the report "Adapting to climate change: the challenge for European agriculture and rural areas" summarizes the main impacts of climate change on EU agriculture, examines adaptation needs, describes the implications for the CAP and explores possible orientations for future action (for a discussion, see Deliverable 4.2). The report notes that:

… projected changes in the mean temperature are not expected to severely disturb agricultural production at the overall EU level before the middle of the century. Nevertheless, before then, we can expect increasingly negative impacts from sharper and less predictable variations in the weather, which will trigger greater variability in agricultural production, food prices and farm income. … Farmers have already begun adapting farming practices and strategies in response to climatic variations – for instance, by adjusting sowing and harvesting dates, changing crop patterns, and taking out insurance against climate-related risks. However, in the coming decades, the climate challenge may overload the individual farmer's capacity to adapt. There will therefore be a need for broader sector-wide responses in order to maintain the strength and competitiveness of EU farmers.

Phase 1 of the White Paper prescribes four pillars of action: 1) building a solid knowledge base on the impact and consequences of climate change for the EU, 2) ensure early implementation of no-regret and win-win measures to avoid mal-adaptation by integrating adaptation into EU key policy areas; 3) employing a combination of policy instruments (market-based instruments, guidelines, public-private partnerships) to ensure effective delivery of adaptation and 4) stepping up international cooperation on adaptation. In each policy area, the following questions should be answered:

- *What are the actual and potential impacts of climate change in the sector?*
- *What are the costs of action/inaction?*
- *How do proposed measures impact upon and interact with policies in other sectors?*

The White Paper makes explicit reference to mainstreaming climate change into agricultural and forestry policy, with the following recommended actions for EU Member States (p. 11, 14):

- Explore the possibilities to improve policies and develop measures which address biodiversity loss and climate change in an integrated manner to fully exploit co-benefits and avoid ecosystem feedbacks that accelerate global warming

– Develop guidelines and a set of tools (guidance and exchange of best practices) by the end of 2009 to ensure that the River Basin Management Plans (RBMPs) are

climate-proofed

– Ensure that climate change is taken into account in the implementation of the Floods Directive.

– Assess the need for further measures to enhance water efficiency in agriculture, households and buildings

– Explore the potential for policies and measures to boost ecosystem storage capacity for water in Europe

– Draft guidelines by 2010 on dealing with the impact of climate change on the management of Natura 2000 sites

- Explore the potential for insurance and other financial products to complement adaptation measures and to function as risk sharing instruments.

The White Paper instructs the Commission, when reviewing in 2012 the implementation of the Water Framework Directive and the Water Scarcity and Droughts Strategy, to evaluate options for boosting the water storage capacity of ecosystems to increase drought resilience and reduce flood risks. (White Paper p.11)

It is instructive that the White Paper also cautions against indiscriminate measures to confront the climate threat "…some adaptation actions that are taken may increase vulnerability rather than reduce it. Some examples of this "mal-adaptation" are sea level rise or flood protection infrastructure that may disturb the natural dynamic nature of coastal and river systems, or cooling or water supply technologies that may increase energy consumption." (p. 8)

In response to the White Paper, Poland is preparing a strategy for adaptation to climate change. To address flood and drought impacts, the Institute of Meteorology and Water Management is developing maps for flood risks, and the RBMPs do address the issue of climate change, with the caveat that it will not have much impact for Poland. While conflicts between protection of birds and habitats within the Natura 2000 network and infrastructural flood defense measures are very common across Poland, Natura 2000 site management plans, which are in preparation, propose compromises that allow for flood and drought prevention at the same time protecting the natural environment. The potential for index-based insurance in agriculture is being explored by the Ministry of Agriculture and Rural Development, the University of Economics in Poznan, the Polish Reinsurance Company, and the Polish Insurance Chamber.

3.2 Structural and cohesion policy

The Treaty establishing the European Communities requires that the Union promotes overall harmonious development and strengthens economic and social cohesion by reducing development disparities between the regions. For this purpose regional spending for 2007-13 accounts for over one third of the EU budget – or some €350 billion. The money comes from three different sources:

- The European Regional Development Fund (ERDF): Funding priorities include research, innovation, environmental protection and risk prevention, while

infrastructure investment retains an important role, especially in the least developed regions.

- The European Social Fund (ESF): Funding priorities include vocational training projects, other kinds of employment assistance, and job-creation programmes.

- The Cohesion Fund: Funding priorities include environmental and transport infrastructure projects and the development of renewable energy. This funding is for 15 countries whose living standards are less than 90% of the EU average (12 newest EU members plus Portugal, Greece and Spain).

The ERDF and ESF are commonly known as EU structural funds. Together with the Common Agricultural Policy (CAP), the Structural Funds and the Cohesion Fund make up the great bulk of EU funding, and the majority of total EU spending. For the 2007–13 period, Poland has been allocated approximately €67 billion, which makes it the largest beneficiary of European Cohesion Policy for this period. The largest national programme is for 'Infrastructure and Environment', which will receive between 2007-2013 almost €28 billion from the ERDF and Cohesion Fund. Over €16.5 billion will be spent via the 16 regional (Voivodships) programmes, giving the Polish regions an unprecedented opportunity to implement their regional development strategies.

The regional development programme in the Wielkopolskie region, entitled the "Regional Operational Programme (ROP) for the Wielkopolskie for 2007–2013" qualifies for Community support for Wielkopolskie. The total budget of the programme is €1.6 billion, and the Community investment through the ERDF amounts to € 1.3 billion. The Wielkopolskie ROP is the region's first ever large-scale, coordinated, multi-annual and financially stable programme of development measures, and it will become the region's most important instrument for making structural changes happen.

Specifically with regard to extreme events or environmental hazards (including floods) the 2007-2013 Operational Programme Infrastructure and Environment (partly funded from the ERDF) will receive 557 million euro from the Cohesion Fund, which provides 85% of the total funding. [Operational Programme Infrastructure and Environment. National Strategic Frameworks 2007-2013, version 2.0. Annex to bill nr 167/2009 of the Council Ministries from 11.September 2009.]

In the past Poland's strategy for the Cohesion Fund (Ministry of Economy, Work and Social Policy 2003) included flood protection within an accompanying strategy for increasing retention in the long term and applying restrictions concerning development within flood hazard areas. Since reservoirs in the lowlands decrease the retention volume of a river valley, and dams are at risk of catastrophic failure for the lowlands, a diversity of solutions was recommended. It should be kept in mind that financing from the cohesion fund is not greater than 85% of an investment, where the remaining 15% in case of reservoir comes from Poland's central budget.

The Jutrosin reservoir can serve as an example of EU funding as part of the Wielkopolskie ROP for a drought and flood risk project in the region. This reservoir is middle-sized with a volume of 2.1 million m3 over about 90 hectares of land (compared with the larger reservoirs such as Wielowieś Klasztorna and Jeziosko with capacities of around 48.8 and 200 million m3, respectively). Construction on

Jutrosin was completed in 2011 with a cost of €6.5 million, of which around 70%, or €4.3 million was contributed by the European Regional Development Fund (Structural fund) and 30% by the Regional Fund for Environmental Protection and Water Management. The reservoir was part of the plan of the Small Retention Programme in Wielkopolskie (among other measures, such as levees and reservoirs) (BIPROWODMEL 2005)

The Small Retention Programme (SRP) is particularly relevant to our discussion in Section 4 on comparing large, middle and small retention projects. This programme is financed by a number of sources, including the Program for the Oder 2006 (funding in 2000-2011 amounted to 9,5% of the Programme or €9.6 million) and the European Fund for Regional Development (EFRD) as part of the Structural Funds (funding in 2000-11 amounted to 31,5% or €32 million). Total spending by the SRP in this period was around € 100 million.

In years 2011-2015 almost 6 million m3 of middle size reservoirs are planned in Wielkopolskie for construction. EU funds for these reservoirs, and also for the planned 356 km of levees, 66,8 km of levee reconstruction after floods, 129,91 km of rivers/streams regulation and 121 200 m3 of increase of floodplain retention, total € 63 million.

3.3 EU Common Agriculture Policy (CAP)

In this section, we examine the EU Common Agriculture Policy (CAP) and its implementation in Poland and the Warta river basin, how it influences policies for drought and flood risk management, and how it takes account of climate change. The history and objectives of the CAP are described in Deliverable 4.2. As shown in Fig. 3.1, there are a range of adaptive practices for flood and drought that are regulated or supported by CAP although without being specifically linked to climate change adaptation or mitigation. Moreover, while EU policies provide support and a legislative context for these adaptation measures, at this time there are no specific strategic documents linking CAP to flood and drought risk management or adaptation practices at the national and local levels.

3.3.1 Pillar 1 and cross compliance

Cross compliance is a key tool for integrating environmental requirements into agricultural policy. Farmers receiving the Single Area Payments (which substitute for Single Farm Payments in the New Member States) are subject to cross-compliance regulation, which obligates them to keep their land in good agricultural and environmental condition and to respect environmental, food safety, phyto-sanitary and animal welfare standards, and thus to comply with, e.g., the Groundwater Directive (80/68/EEC), the Nitrate Directive (91/676/EEC) and to apply Good Agricultural and Environmental Practices defined by Member States (Duer et al. 2004). If farmers fail to comply, their payment will be reduced. Cross-compliance represents the "baseline" or "reference level" for agri-environment measures, i.e. it sets a fundamental standard of environmental performance that a farmer must achieve to be eligible for payments. Following the "Polluter-Pays-Principle," farmers must bear all compliance costs to meet requirements falling under cross-compliance.

The latest CAP "health check" (2010) fully de-couples payments from production and strengthens the requirements for compliance with environmental standards. It includes water management and climate adaptation/mitigation (also biofuels) alongside social-economic goals in it expressed purposes. While the CAP cross-compliance requirements have addressed water scarcity and other anticipated impacts from climate change, the Health Check is a more explicit step in the mainstreaming of climate change into sectoral policies. *The Health Check is a big step forward, and opens the door for explicit flood, drought and climate change action; yet, the extent and nature of this action will depend on Member States.* From 2010 Member States are required to define standards applying at farm level for compliance with existing national authorization procedures. For the Warta basin, the standards laid out in the Code of Good Agricultural Practice published by the Ministries of Agriculture and Environment in 2004 are valid for cross compliance today.

A strong link now exists between agriculture and water policy. The CAP Health Check has established new Good Agricultural and Environmental Practices related to water standards. These include, for example, the ***establishment of buffer strips along water courses*** (1.01.2012) and compliance with authorization procedures for irrigation where applicable (due 1.01.2010). The "Code of Good Agricultural Practice" (Min. of Agriculture 2004, p. 72) adds to these requirements that farmers should maintain drainage installations and infrastructure as well as perform anti-soil erosion practices, re-cultivation of areas deteriorated after natural disasters, ***designate locations on private land for technical infrastructure, such as ponds, small water retention reservoirs for flood protection and future production purposes.*** The CAP area payments provide additional subsidies for farmers who install ponds (under 100 m^2), which compensates them for their reduction in the area payment since the pond reduces their arable land) as well as for buffer strips. However, the Code does not explicitly address drought and flood risk management. Still, as we see on Fig. 3.1, many if not most practices that reduce the risk of flood and drought can be required as cross compliance conditions or as subsidies linked to area payments.

Moreover, farmers are required to insure at least 50% of their agricultural production against floods and droughts if they apply for EU agricultural subsidies. As discussed in Deliverable 4.2, insurance is an adaptation measure insofar as it spreads those losses that cannot be (or are not) cost effectively reduced thus reducing the economic burden to flood and drought victims. If adequately designed insurance contracts can lead more directly to adaptation by including incentives for loss reduction investments. In Poland the premiums are subsidized by 50% from the central budget (Law on Insurance of Agricultural Production and Farm Animals 2008). The Ministry of Agriculture is preparing a proposal of a new scheme where 35% will be paid by farmers, and the rest subsidized from the central budget with EU support. The EU supporting funds would be taken from the 10% of the direct payments in agriculture, which each Member State has a liberty to spend to support national objectives.

Cross-compliance rules concerning protection of the natural environment (Scheme A) entered into force as of 1.01.2009. This requirement concerns protection of wild birds and habitats, protection of groundwater against dangerous substances, wastewater treatment on a farm, protection of water bodies against nutrients contamination. (ARiMR 2010))

Non-compliance with the cross-compliance requirements can result in a reduction of 3-20% (and up to 100%) of the subsidies within CAP area payments.

3.3.2 Pillar 2: European Agricultural Fund for Rural Development (EAFRD)

The European Agriculture Fund for Rural Development (EAFRD) will co-finance actions for rural development in Member States in line with the rural development plans submitted by each country. As described in more detail in Deliverable 4.2, the Rural Development Programme is based on the multi-functionality of agriculture in rural areas. Under EAFRD, Poland receives EUR 13.2 billion in the period 2007-2013 that together with the national funds constitute a total budget in the amount of EUR 17.2 billion for rural development. Poland has prioritized the funding to support farming in mountain areas and in less-favoured areas (LFA), the agri-environmental programme, afforestation, and restoring forestry production potential damaged by natural disasters and introducing appropriate prevention instruments.

3.3.2.1 Agri-Environmental Program

The CAP reforms of 1992 included a 5-year Agri-Environmental Measures (AEM) backed by EU payments that (fully) compensated farmers for their loss of income if they joined voluntarily the program. As discussed in chapter 3, in the ongoing period 2007 - 2013 expenditure on agri-environment measures (co-financed by Member States) will amount to nearly 20 billion EUR or 22% of the expenditure for rural development. CAP agri-environmental schemes (AES) seek to bring benefits on various levels such as: food quality improvement for health, managing carbon emissions from agriculture (mitigation), and restoring or re-creating wildlife habitats for the improvement of biodiversity, and as such are a key mechanism for influencing land management across Europe. They are implemented through voluntary agreements open generally to all farmers, lasting typically 5 or 10 years, when farmers agree to implement a range of specified management practices, such as protecting soils and water, maintaining or enhancing biodiversity and traditional farm landscapes, *in exchange for payments co-financed by EU and Member States.* In contrast to the newer cross-compliance measures, the AES relies on "carrots" or payments to farmers. Particular emphasis has been given to extensive agriculture in highly valued natural areas.

While the early AEM did not explicitly incorporate measures for flood and drought risk management, nor for climate policy, it set the stage for later reforms that would take these concerns into account. Inadvertently, however, the strategies did address flood and drought risk. For instance, farmers are paid for maintaining pastures instead of cultivating crops, a substitution that increases water absorption and thus decreases downstream risks of flooding. Other measures that in principle qualify for agri-environmental payments include the maintenance of buffer zones near water bodies and the planting of shelter belts (Scheme 9 of Agri-Environmental Programme within the Rural Development Programme for 2007-2013), maintenance of non-arable land, and soil and water protection to increase water retention in the soil. Note that these measures take the form of "carrots" by proving farmers with monetary incentives for taking risk-reduction measures that benefit mainly downstream parties. "Sticks" are also in place. It can be recalled from the Pillar 1 discussion above that cross

compliance measures in Poland require that farmers maintain drainage installations and infrastructure as well as perform anti-soil erosion practices, re-cultivation of areas deteriorated after natural disasters, designate locations for ponds, small water retention reservoirs. Looking at Fig. 3.1, we see that AEM and cross-compliance measures (carrots and sticks) cover nearly the full range of on-farm actions available to farmers to mitigate flood and drought risks in the Warta basin.

Besides agri-environmental measures, the EAFRD has other relevant programs, for instance, for afforestation that serves not only as a CO2 mitigation measure but also, by slowing runoff, increases the water storage capacity of the landscape. According to the law and regulations ("Afforestation of Rural Areas" 1257/1999-EU Council Directive), farmers' receipt of subsidies requires that production be ecological and protect and shape the rural landscape. The Rural Development Financial Plan 2007-13 foresees the cost of afforestation throughout Poland at about €653.5 million, of which the EAFRD will contribute €522.8 million. According to the EU Council Directive 1257/1999, EU sponsorship does not cover communal land. However, afforestation in Poland is carried out both on private and public land (Dzikowska et al. 2006). Finally, there is the Life+ program, which operates through the Polish National Fund for Environmental Protection and Water Management to finance projects aimed at protecting the environment, e.g. construction, reconstruction and restoration of the hydro-mechanical structures within one of priority programmes, e.g. Programme 2.1 (Polish National Fund for Environmental Protection and Water Economy (2012).

Looking at Table 3.1 we see that a main instrument operationalizing the EAFRD is Poland's Rural Development Plan (RDP) for 2007 to 2013, which, however, is not the only plan governing investment in flood and drought risk management. Other plans relevant for the Warta basin are listed below:

- National Development Plan 2007-2013 (NDP)
- Assessment of the state of Flood Protection of Wielkopolskie Viovodship (2010)
- Programme of small retention of water in Wielkopolskie Voivodship (2005)
- Programme for preventive flood protection in the Odra river basin with special attention to the Warta river basin and the Szczecin lagoon – Odra Region
- National Strategy for Regional Development (supported by the EU). Investment in flood protection infrastructure is one of the aims of the regional policy
- Strategy for Rural Development and Agriculture 2007-2013 (SRDA) Programme of Environmental Protection for a Voivodship
- Program for Oder 2006
- Local (community) spatial plans

It is beyond the scope of this section to describe these programs and strategies. Yet, one important observation is that the regional strategies for the Warta basin identify

economic development as a main goal. This means for the northern Warta catchment an intensification of agricultural production.

3.3.3 Proposed CAP reform and outlook

The current reform proposals are intended to meet the objectives set for the new CAP, namely 1) viable food production; 2) sustainable management of natural resources and climate action; and 3) balanced territorial development. The approval of the different regulations and implementing acts is expected by the end of 2013, with a view to having the CAP reform in place as from 1st January 2014.

Generally, the CAP reform will mean a reduction in the overall CAP budget, but with the intent to shift a greater part of the funding to the EU's newer member states from Eastern Europe. Of most interest to this discussion, the Commission's CAP proposals will place a greater emphasis on environmental measures, with up to 30% of the funding granted to the improved use of natural resources. These measures include what is already supported by AES and cross compliance measures, for instance, crop diversification, maintenance of permanent pasture and the preservation of environmental reservoirs and landscapes. One particularly interesting policy intervention to slow and retain runoff would be a requirement that farmers keep at least 7% of their eligible hectares (as defined in Article 25(2)) as "*Ecological Focus Areas*": defined in article 25(2)(b)(ii) as land left fallow, terraces, landscape features, buffer strips and afforested areas (European Commission 2011). *As more funds will shift to these so-called 'green payments', there is great potential for support for flood/drought management and climate adaptation/mitigation.*

The Commission is also proposing to support farmers' income in a "fairer, better targeted and simpler way". Basic income support (replacing single farm payments) will no longer be based on historical payments (a reform welcomed by Polish policy makers) and will cover only active farmers. There is a great deal of concern in Poland, however, that the new CAP budget architecture may significantly lower EU financial assistance to Polish farmers and depress a sector that employs almost one-seventh of its work force. The change of structural funds infrastructure is to be accompanied by reduced individual subsidies for farmers that constitute the second biggest source of EU aid for Poland.

With regard to the Rural Development Program, the axes have been replaced by the following six priorities (emphasis placed on those relevant to flood, drought and climate change):

- Fostering knowledge transfer and innovation in agriculture, forestry and rural areas;
- Enhancing competitiveness of all types of agriculture and enhancing farm viability;
- Promoting food chain organisation and risk management in agriculture;
- Restoring, preserving and enhancing ecosystems depending on agriculture and forestry;

- *Promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sectors;*

- Promoting social inclusion, poverty reduction and economic development in rural areas.

The proposals continue to place a strong emphasis on achieving the strategic objectives and delivering on the priorities through the continued provision of agri-environment schemes. *The agri-environment-climate measure must be available within a rural development program, and contains an additional focus on climate change mitigation and adaptation.*

Finally, the Commission places a greater emphasis on the problem of water stress in its proposals for reforming the CAP. A predominantly high level of water stress will be proposed as one of the biophysical criteria for defining areas with natural constraints, which includes much of the Warta basin, with support for measures that mitigate this stress, such as investments in water storage and appropriate cropping techniques.

3.3.3.1 *Stakeholder views*

The CAP reform has been praised as moving the CAP further in the direction of environmental protection; yet some claim not far enough. According to the WWF, not 30% but 100% of direct payments to farmers should be linked to green measures (WWF 2011).

Comments from the Polish government on the CAP reform are both positive and negative. There is a great deal of concern about increasing the complexity and administrative burden of the CAP but also appreciation of attempts to reduce this burden, particularly for small farms with lump sum payments conditional on cross-compliance regulations. There is praise for keeping the high degree of autonomy for the MSs, and also taking account of cohesion in the budget allocation of the rural development program, but there is concern about reducing the EU contribution in co-financing agri-environmental and forestry programs from 80 to 75%. Importantly for this discussion, the Polish government applauds the greater emphasis on climate change and innovation for investments in rural development (Bayer et al 2012).

The CAP, as perceived by many stakeholders, is well structured to give space in the future (2014) for Member States to determine the directions of spending CAP money. Whether at the country and regional level these directions will be well tailored to meet specific needs remains an open question.

3.4 The EU Water Framework Directive

The EU Water Framework Directive (WFD), which was enacted in 2000, was the first comprehensive water policy in Europe, requiring Member States to develop river basin management plans, and reach a good ecological status of their water courses by 2015, or latest 2027. The WFD is discussed extensively in Deliverable 2.2, and in this section we examine how it is being implemented in Poland and the Warta region. Specifically, we ask how it is relevant to the flood and drought risk management measures for the Warta, and how it coordinates with the CAP.

In compliance with the WFD Poland has designated eight River Basin Districts, including the Oder basin for which the Warta is a subsidiary. Like all framework directives, the WFD does not lay out detailed regulations, but sets broad requirements and leaves considerable discretion to Member States in its interpretation. It has primarily addressed water quality; yet many of its requirements are relevant to drought (especially for water scarce areas) and flood.

Irrigated agriculture has been identified as the major sustainable water management issue in the implementation of the WFD. In the Warta basin, however, irrigation is limited. Only 4% of the 1,232,600 ha of agricultural land that needs irrigation and drainage is irrigated, although this may change as droughts intensify in this region as a result of climate change.

3.4.1 Implementation of the WFD in Poland

In Poland, the WFD stipulations with regard to water quality and (quantity) have recently been interpolated in Polish water law. Since the WFD focuses largely on water quality and ecological water management, there is little attention in the Polish legal acts that pertain to flooding, droughts and water quantity. As mentioned above, this is partly corrected in the Flood Directive (FD) referred to as its 'daughter directive', and in the EU Water Scarcity and Droughts Strategy, which are discussed below. An exception is the WFD requirement for River Basin Management Plans (RBMPs), which are supplemented by Flood and Drought Management Plans.

The following requirements of the WFD have been implemented in Poland:

- Transposition of the directive into the national legal system (art. 29 WFD)
- Identification and characterization of River Basin Districts and their authorities (Poland has designated eight RBDs)
- Establishment of a monitoring network (art 8)
- Public consultation in preparation of RBMPs
- Finalization of RBMPs including progammes of measures (art. 13 & 11) (the plans were adopted in Poland in 2011).

Requirements still pending implementation include:

- Introduction of pricing policies (due 2010) (art 9)
- Implementation of measures (due 2012) (art. 11).
- Monitoring fulfillment of environmental goals (by 2015)
- Second river basin management plans and the first flood risk management plans (by 2015).

The EC has intervened to press Poland to meet WFD deadlines, and, on one occasion (regarding assessment of flood risks) threatened legal action against Poland. At this writing, Poland is no longer delinquent in meeting the timetable for

implementation of WFD and the Flood Directive (FD), and is striving to meet the mandated requirements, with the possible exception of meeting water quality targets. However, the implementation of the measures defined in the directives is still ongoing.

Planning in water management with regard to floods and droughts, according to Polish water law, is prescribed in many different documents. In addition to the River Basin Management Plans, the WFD requires drought management plans for the river basins; and Polish law and the FD require flood protection plans for the water regions. The plans should be reviewed and revised in 6–year periods. The most important institutions responsible for planning at the regional level are described in Deliverable 4.2.

3.4.2 Implementation of the WFD in the Upper Warta: the River Basin Management Plans (RBMPs)

Following an extensive public consultation process, Poland's first-cycle River Basin Management Plans were adopted in 2011. Plans for the Upper Warta are contained in the Oder RBMP.

The Oder RBMP was based on a 2009 Environmental Impact Assessment, which required that the RBMP have positive impacts on the natural environment and landscape and especially water quality. Currently a social consultation process to update the RBMPs is being carried out. The process has revealed a need for unifying information provided by Regional Water Management Authorities (RWMAs/RZGWs) and other sources as well as developing a unified approach to data collection.

3.4.2.1 *Stakeholder views*

Stakeholders suggested that the retention goal should be added to the Polish water law and maybe to European directives. They also stressed the importance of basin-focused management as a key principle regarding water management in Poland and in the Warta water basin. Placing responsibility for hydrological infrastructure in the hands of many different authorities makes the management very complicated as well as ineffective and inefficient. As an illustration, consider the large Jezirosko reservoir. In this case, the dam belongs 1/3 to Wielkoposkie Voivodsip, 2/3 to Lodzkie Voivodship, 1/6 of the reservoir belongs to Wielkopolskie, 5/6 to Lodzkie. The interests of Lodzkie are to have as much water as possible in the reservoir (tourism, nature, irrigation), whereas Wielkopolskie has a major interest in flood and drought protection. There were cases when Wielkopolskie wanted to release water from the reservoir, but authorities from Lodzkie were opposed. The Regional Water Management Board (RZGW) in Poznan has to make such decisions. There would have been an open conflict of interests when administrative and not basin based water management would be implemented. For this reason, a basin water management authority is viewed as essential and the improvements should concern clearly defined responsibilities of the organizations involved in the management, as well as increased availability of financing for the management and maintenance of water infrastructure.

Stakeholders at the Responses workshop recommended adding a WFD requirement for self-financing of water management as well as more frequent consultations

between EU directives and Polish law with water management practitioners. Moreover, better integration of environmental and water management regulations was recommended.

3.4.3 The inclusion of climate change in the RBMPs

The FD and the Common Implementation Strategy (CIS) for the WFD state that uncertainty related to ***climate change*** should be presented transparently in flood maps, and climate change scenarios included in ongoing initiatives and in planning processes. Guidance has been given on including climate change for planning purposes in the EC document, "River basin management in a changing climate - a Guidance document". In the RBMPs for Vistula and Oder, however, it is stated that for the first planning cycle of the WFD the foreseen climate changes will be of very little importance to impacts for actions identified in the plans. The increase of temperature of 2 degrees in the country is probable only in the second half of the 21st century. It is expected that within the time frame of WFD implementation (i.e., up to 2027) a climate change signal will thus not be statistically distinguishable from the effects of other human pressures, including elevated water abstractions for irrigated agriculture, changing population and capital, new flood defense infrastructure or effects on water quality and quantity of intense production of energy crops. This is the assumption also underlying our estimates (Deliverable 4.2) for drought and flood risk in the Warta, where drought risk was calculated for the period 2030-2060 and flood risk for 2071-2100.

This does not mean that the Oder RBMP did not discuss possible climate change in the basin. Historical hydro-meteorological conditions were described together with prognoses for the future climate. It was concluded that due to increasing precipitation and frequency of convectional cloudiness, there would be an increased frequency of floods, intensive rainfall and drought periods.

Stakeholders in general think that more research should be done on climate change and such analysis should be included in the RBMPs. More specifically the following views were presented:

In hydrology, the estimates are based on rainfall probability and this should be changed, because the risk nowadays does not depend only on rainfall probability, but it is mainly caused by and should be attributed to land use/changes in the land use in the catchment. Note that in Deliverable 4.2, we addressed these ch*allenges to flood risk assessment* by p*roviding an il*lust*ration of a pr*obabilistic-based catastrophe model for estimating flood losses in the Warta bas*in*.

In Polish there are two different words for flood: wezbranie (rising level of water) and powódź (flood). Powódź (flood) is defined as a rising water level that causes damages. Wezbranie (rising level of water) does not cause damages. The failure to distinguish these words in EU directives causes confusion when the directives are transposed to the Polish legal system, also influencing changes in flood management in Poland.

3.4.4 Drought and flood risk management measures in the Oder RBMP.

The Oder RBMP measures for flood and drought risk management do not depart significantly from those found in Polish water law (national and regional strategies and programs). These measures are listed in green on Fig. 3.1 and are described in more detail below:

- preparation of a flood protection study (programme) with flood hazard maps;
- construction and reconstruction of levies, polders and other flood protection measures;
- implementation of projects to increase water flow in rivers;
- prevention of settlements and other infrastructure in the floodplains;
- protection of wetland areas, afforestation;

  usage of the existing irrigation systems in order to maintain wetlands and meadows – and if possible – reconstruction of wetlands (wetlands reparation).

Note that the Oder RBMP has little mention of non-structural measures for flood and drought prevention, such as the on-farm measures identified in Table 3.1. These include mainly measures to increase water retention in the countryside, such as cropping, tilling, small ponds, and other farm practices as well as buffer strips, shelter belts and land use measures.

According to the EU's Climate Change & Water Guidance document, it is expected that climate change will be fully integrated into river basin management for the 2nd and 3rd RBM cycles. This will require Polish officials to demonstrate how climate change projections have been considered in the assessment of impacts, monitoring programmes and appraisal of measures. The Guidance includes: (1) how to include available scientific knowledge and take account of uncertainties about climate change; (2) how to develop strategies that build adaptive capacity; (3) how to integrate adaptive management within the RBMP and how to address the specific challenges of managing future (4) flood risk and (5) water scarcity. Specific to flood and drought risk management, the Guidance puts forth the following principles:

- Start adapting flood risk management to potential climate change as soon as possible, when information is robust enough since full certainty will never be the case. Follow the guiding principles set out for the WFD.
- Use the Water Framework Directive as the basic methodological framework to achieve climate change adaptation in water scarce areas and to reduce the impacts of droughts.

3.5 The EU Floods Directive

Directive 2007/60/EC on the assessment and management of flood risks entered into force in November 2007. As discussed in Deliverable 4.2, the current version requires Member States to assess water courses and coast lines for their risk

from flooding, to map the exposure (assets and humans at risk) and to take adequate and coordinated measures to reduce flood risk.

The Flood Directive shares many features of the WFD, such as the cyclical approach, preparation of management plans and the public consultation process. However, what distinguishes the Flood Directive from the WFD is that it places safety and risk management issues at the centre. The Flood Directive further highlights the need for coordinated action on climate change throughout the RBD; yet the Preliminary Flood Risk Assessment also requires that past floods are taken into account, so efforts to homogenize and remove biases from river flow records will be helpful to trend detection more generally.

As pointed out in the Climate Change & Water Guidance document, WFD and flood risk management objectives potentially overlap in several places with respect to climate change. For example, more frequent floods can have benefits for aquatic ecology, soil fertility, groundwater recharge and biodiversity. Moreover, some types of floods as well as some types of flood management measures (such as wetland restoration) can also have beneficial aspects for increasing the climate change resilience.

The FD instructs Member States to consider long term developments, including climate change, as well as sustainable land use practices in the flood risk management cycle. In fact, climate change should be considered in the first flood risk planning cycle within the preliminary flood risk assessment, as well as in subsequent cycles of planning, when updating the preliminary flood risk assessments and the flood risk management plans. As noted above with respect to the RBMPs, on the basis of current knowledge, however, it is unlikely that within the timeframe 2012- 2027, the effects of a climate change signal will be adequately distinguishable from other human pressures and natural variability. It is more likely that climate change related effects on floods can be expected from trends in settlement and land use.

While climate change is not considered relevant for the current planning period (until 2027) this does not mean it is not relevant for long-term investments, like levies or reservoirs that will outlive the planning period. Still, risk estimates that take account of climate change, and are robust for policy making, are still in their infancy (as shown by our estimates in Deliverable 4.2). In addition to climate change, other non-stationary pressures will be (even more) relevant for flood risk assessment. Moreover, flood risk management has yet to account for the contending views of stakeholders on structural versus non-structural measures for flood mitigation. The EU has not issued communications that address these difficult assessment and policy hurdles. *In fact, at this time there are no specific strategic documents linking CAP to flood and drought risk management or adaptation practices at the national and local levels.*

3.5.1 Implementation of the EU Floods Directive in the Warta basin

In accordance with the FD, Flood Risk Management Plans (FRMPs) will be prepared by 2015 following flood hazard and risk mapping (2013) and preliminary flood risk assessment (2011). They should contain information on Member State flood risk management objectives and identify specific measures to achieve these objectives. The measures must also take into account objectives of the WFD.

Some progress is being made on initial flood risk assessment in Poland. For instance, Polish centers for flood modelling, the Institute of Meteorology and Water Management (IMGW) and the National Water Management Board (KZGW) have modeled flood risks across Poland. The analyses highlight a number of challenges, especially the problems of including spatial development in the assessments of future risk due to a lack of required data (e.g. in the Warta water region there is lack of data on infrastructure/settlements development and economic zones). Also, due to deficiencies in data sets the influence of climate change has only been included for areas near the Baltic Sea. Still, progress is continuing. A consortium of the Institute of Meteorology and Water Management (IMGW), the National Water Management Board (KZGW) and Ministry of Administration and Internal Affairs is developing a planning tool, "Information System of Country Protection from Natural Disasters". (Jadczak 2011)), which will have publicly accessible maps of flood hazard zones and models simulating floods and their consequences. The tool should be in operation in 2012. Stakeholders emphasized that the FD requirement for flood hazard and risk maps is a step in the right direction to gain knowledge about the risk. Without EU support these maps would not be financially feasible in Poland. The development of an appropriate methodology was financed by the National Fund for Environmental Protection and Water Management, and the mapping, itself, is financed from European Fund for Regional Development within the Operational Programme Innovative Economy. Stakeholders also noted the challenge of including climate change in the flood risk maps, especially the data collection. The planned future flood risk maps will include such parameters as: velocity of water flow, depth ranges, and spatial development.

3.5.2 EU Water Scarcity and Drought Strategy

At the outset it should be pointed out that drought and water scarcity are related but separate issues. Droughts are temporary deviations of the natural water cycle from the long-term average; water scarcity is a long-term, systemic imbalance between water supply and demand. Both supply and demand have the potential to affect the status of water bodies as the frequency, duration and intensity of droughts could change in the future. We have addressed water scarcity issues in the Upper Guadiana case study. The Warta is a case illustrating a seemingly worsening drought context, where some parts of the Warta are also considered water scarce (see section 5.2).

In 2007 the European Commission published its Communication on water scarcity and droughts in the European Union (COM (2007) 414 final). The Communication identified seven main policy measures to address water scarcity and drought issues:

- Putting the right price tag on water
- Allocating water and water-related funding more efficiently
- Improving drought risk management
- Considering additional water supply infrastructures
- Fostering water efficient technologies and practices

- Fostering the emergence of a water-saving culture in Europe
- Improving knowledge and data collection

Given the high degree of uncertainty in climate change projections and the growing pressure on water resources, the EU Climate Change & Water Guidance document stresses the importance of hydrometric networks to monitor droughts, water demand and long-term trends in water supply.

A further priority is to intensify efforts to manage demand and thereby reduce pressure on water supply sources, especially in times of droughts, where the greatest scope for action is in reducing irrigation demands which often account for the largest fraction of total demand in water scarce regions.

Drought Risk Management Plans (DRMPs) are in initial stages of development. They will be prepared for high-risk areas after the risk has been assessed.

3.6 EU support for hazard insurance

In Deliverable 4.2 we described the state of agricultural insurance across Europe, and the status of crop and property disaster insurance in Poland. We also examined the European Union Solidarity Fund (EUSF) as a main EU instrument for providing funds for post-disaster reconstruction particularly in the new Member States.

To date, with the exception of the EUSF, there has been little intervention in insurance markets and regulation by the EU, although it is discussed in the pending reforms of CAP. It appears that the EU is endorsing highly subsidized crop insurance, which may be problematic from the viewpoint of climate change adaptation.

3.7 LIFE +

The LIFE programme is the EU's funding instrument for the environment with the aim of contributing to the implementation and development of EU environmental policy by co-financing pilot or demonstration projects with European added value. LIFE began in 1992 and to date there have been three complete phases of the programme with the co-financing of 23 projects in Poland since 1992, focusing on environmental innovation (4), nature conservation (15), capacity building (1) and information and communication (3), including one project on conservation of waterfowl and wading birds in the Warta Mouth National Park (European Commission, DG Environment – LIFE Unit 2011). The current phase of the programme, LIFE+, runs from 2007-2013 and has a budget of €2.143 billion.

The Polish National Fund for Environmental Protection and Water Management (2012) operationalizes LIFE+, and is subsidizing, among other environmental projects, the construction, reconstruction and restoration of hydro-mechanical structures (Programme 2.1 Construction, reconstruction and restoration of the hydro-mechanical structures).

3.8 Stakeholder views on EU measures for supporting flood and drought risk management in the Warta region

Stakeholders appreciate the EU support given to reservoir construction and other public infrastructure projects, and generally agree that a portfolio of public infrastructure and private on-farm measures are necessary to reduce flood and drought risk in the Warta region, and thus adapt to climate change. However, many stakeholders are concerned that too little consideration, analysis and financial support is allocated to the on-farm measures.

The needs for investments in flood and drought protection and adaptation measures are vast, due to inefficient development of hydro-technical infrastructure and overinvestment in the past. A major challenge is maintaining the infrastructure given tight public budgets (EU, national, regional). At the same time pressure for economic development together with careless spatial planning add to the need for further investments in hydro-technical measures. Therefore, financial support of these measures as well as incentives for implementation of other cost effective measures that reduce flood and drought risk and losses, such as shelter belts and conservation tillage, are needed. Detailed studies on the effectiveness of low-tech alternative measures are welcomed. Stakeholders view many of these practices as required for implementation now, relevant for adapting to contemporary flood and droughts problems and also as precautionary principle, for the future climate change.

Stakeholders view EU policies as steps in the right direction. Recommendations include: i) strengthening the policies (including more requirements, and more detailed ones), ii) increasing economic incentives for the private sector to invest and manage the measures effectively, and/or iii) improved policy implementation and planning such that impacts are anticipated and in order to avoid negative side effects.

4 Integrated and robust options for reducing drought and flood risk (adaptation) and contributing to climate change mitigation

This discussion has examined the portfolio of on-farm, off-farm and market-based agriculture/hydrological measures for managing flood and drought risks in the Upper Warta region, and thus adapting to climate change as well as (in some cases) contributing to its mitigation. We have also reviewed EU policy and policy measures that are relevant for this portfolio of flood and drought risk measures. We conclude that a strong portfolio of EU funds, regulations, guidelines, etc. are in place in the agricultural and water sectors for reducing the risks of floods and droughts. In some important cases, most notably afforestation and conservation crop tillage, these measures also have potential to contribute to climate change mitigation.

With regard to EU funding, the Structural Funds and Cohesion Fund and the CAP EAFRD are the two largest sources for funding agricultural and water projects. The greater part of these funds (mainly from the Structural Funds and Cohesion Fund) have financed public, off-farm projects, like reservoirs, levees and polders, which have been targeted mainly to reducing flood risk. With the latest CAP "health check", an important opportunity exists to finance smaller, on-farm measures that contribute to adaptation by retaining water in the landscape and thus reducing flood and drought risk, and also to mitigation by sequestering CO2 in soils and woodlands. The extent to which the Commission emphasizes on-farm water retention measures should depend to a large extent on their costs and benefits compared to off-farm water retention measures. This will be the subject of Deliverable 4.5.

Although many analyses have been carried out for large infrastructure projects, such as reservoirs, we have not been able to identify analyses that comparatively examine on-farm measures for the purpose of retaining water. Since in many cases on-farm water retention measures have the co-benefit of sequestering CO2, it is important to compare the different on- and off-farm measures. This is particularly relevant to the Commission as it proceeds to implement policies that could, in principle, provide funding, incentives and requirements for on-farm measures. In what follows, we identify and select relevant on- and off-farm measures, each with the primary purpose of retaining water in the landscape, but with different contributions to climate change adaptation and mitigation.

4.1 Selected agricultural/hydrological policy options for adapting to and mitigating climate change

In this section, we describe selected off-farm and on-farm measures, each of which has a primary purpose of retaining water in the landscape and thus reducing flood and drought risk, and therefore contribute directly to climate adaptation. In addition, the on-farm measures have the co-benefit of advancing mitigation, as well as other co-benefits, such as supporting bio-diversity.

Our selected measures include:

- Off-farm: large-size reservoirs,

- On-farm: ponds, afforestation (including shelter belts) and conservation tillage practices.

Besides their different contributions to adaptation and mitigation, we choose these measures for several reasons, including:

- The Commission places a great emphasis on the problem of water stress, for example, in its proposals for reforming the CAP and the requirements for the WFD. A predominantly high level of water stress will be proposed as one of the biophysical criteria for defining areas with natural constraints, which includes much of the Warta basin, with support for measures that mitigate this stress, such as investments in water storage and appropriate cropping techniques;

- The IPCC report on extremes (SREX) noted the difficulties of determining the contribution of climate change to current flood and drought risk, and even estimating attribution in the future. For this reason we explore robust solutions to the flood and drought problem. One robust solution is ***increasing water retention in rural areas***, which is important both for increased dry periods (droughts) and, because it lowers risk to urban areas, for increased wet periods (floods). The four types of interventions each contribute to water retention in the rural area, which is considered by both experts and stakeholders as important for reducing both flood and drought risk, and thus adapting to climate change, in the Warta region;

- The comparison of off-farm reservoirs with on-farm practices is important for climate change mitigation, as well. In contrast to large reservoirs, the on-farm measures not only contribute to water retention but also to climate change mitigation by increasing carbon sequestering in pond areas, soil through reduced tillage and forests;

- In the Warta, there is concern that existing water planning practices (mainly supply-oriented) may prove inadequate to cope with the adverse impacts of drought, leading to overexploitation of water bodies (e.g. rivers and reservoirs). As a result aquatic ecosystems may be jeopardized;

- Among the many on-farm measures to improve water retention, ponds, afforestation (including shelter belts) and tillage practices stand out as having a great deal of potential for both adaptation and mitigation; however, their cost effectiveness has not been rigorously assessed.

Finally, we have noted in this discussion both financial and regulatory support, as well as disincentives, for these water-retention measures, most notably:

- Large reservoirs qualify for substantial funding from EU structural funds. This EU funding is consistent with past and current priorities for managing flood and drought risk. The Oder RBMP, as one case in point, has little mention of non-structural on-farm measures for flood and drought prevention. Publicly constructed reservoirs can also be justified by increasing demands for irrigation, partly encouraged by the failure to price water for irrigation.

- Private afforestation activities can also qualify for funding under the CAP's EAFRD (80% of financial support); however, at the same time the area-based

payments to farmers is higher for arable than forest land, creating a disincentive for planting trees. This may also be a disincentive for shelter belts.

- Small on-farm reservoirs or ponds, if they are less that 100m2, can receive support from the EU (AEM); however, this support only serves to counter-balance the loss in EU payments from taking land out of cultivation for the pond construction.

- While the WFD mandates water pricing; Poland's Environmental Protection Law excludes irrigation by surface waters. Water consumption from public reservoirs, therefore, is less costly to farmers than providing for their own sources with micro-reservoirs or other means of retention.

- Finally, conservation tillage practices are also not required or funded by the EU in the Warta region. Changing tillage techniques constitute the most radical departure from current and historical practices, which means, if they are deemed to be cost effective, they would need to be slowly introduced to farmers. This could potentially be part of the agri-environment program with subsidies for changing machinery, etc, as well as Life+ for funding pilot programs. Note that EU and Polish legislation that is not directly related to water retention can also have an influence on the financing and uptake of these measures. As noted above, Poland's decision not to apply water pricing to surface water usage for irrigation indirectly supports the free use of publicly funded reservoirs and thus discourages private investments in on-farm reservoirs and other private water collection measures. As another case in point, the EU requires that 50% of agricultural crops are insured; however, it also condones heavy subsidization of this insurance by the government. This reduces incentives for farmers to invest in measures, like small reservoirs, that reduce their losses from drought.

In what follows, we discuss these measures with regard to their current status and discussion in the Warta region, as well as the current support (and in some cases disincentives) from the EU. We consider two policy options or paths for the Commission: (1) continue EU support for large reservoirs, and (2) intensify EU support for on-farm water retention measures. In Deliverable 4.5 we provide evidence on the quantitative and qualitative costs and benefits of these two options, taking account of climate change where feasible.

4.1.1 Policy option 1: continue EU support for large reservoirs

The construction of reservoirs that serve both flood and drought protection is a major and topical policy option in the Warta region. The Oder RBMP measures for flood and drought risk management include the construction and reconstruction of levies, polders, reservoirs and other flood protection measures. The water management strategy for Wielkopolskie Voiviodship focuses largely on large- to medium-scale infrastructure projects. This reflects also the discussion throughout Poland, which currently has 40 reservoirs retaining more than 10 million m3 of water, and 11 very large reservoirs with a volume higher than 100 million m3 of water. However, retention capacity in Poland is only at a level of 6%, whereas in several neighboring states is at the level of 10-12%. (Ministry of Economy, Work and Social Policy, 2003)

Wielkopolska's reservoir strategy is described in Section 2.1.2, where it is noted that a number of reservoirs of varying sizes are planned for the period 2005-15 as part of the Programme of Small Retention of Water in Wielkopolskie Voivodship (2005). The EU is involved in subsidizing the construction of these and other reservoirs through the European Regional Development Fund (ERDF) as part of the structural and cohesion funds. Poland's National Strategy for Regional Development and its Programme for Flood Protection in the Odra river basin consider investments in flood protection infrastructure as part of their main strategy. Another EU fund that can play a role in financing reservoirs is the EAFRD, which would be implemented through Poland's Rural Development Plan (RDP) for 2007 to 2013. It has not provided funding for Wielowies Klasztorna, however, because it can provide support only for middle- ad small-sized reservoirs.

4.1.1.1 Test case: the Wielowieś Klasztorna reservoir

A good test case for examining the issue of EU support for Poland's and other Member States' reservoir policy is the Wielowieś Klasztorna reservoir, which is currently under construction and planned for completion in 2015. Relative to existing reservoirs in the Warta river basin, this reservoir will rank as one of the largest (see Table 2.3) with a dam height of nine meters, and an expected retention capacity of 48.8 million m^3 over an area of 20 km^2. The Wielowieś Klasztorna reservoir has experienced a long planning period given the many hurdles for permits, analyses, purchase of land, procurement of funds, etc.

A requisite cost-benefit analysis estimated the investment costs of the Wielowieś Klasztorna reservoir to be (only investment cost) 77 million euros[1]. The net present value of the investment was estimated within a range of -36,8 to 21,2 million euros, depending on the cost level avoided (range from zero to 90 million euros) in the flood scenario applied (see Section 4.1.1.2). For all five flood scenarios the annual benefits were calculated using the same option: the biggest reservoir (area 387 ha, volume 32,5 mln m^3). These benefits total to 88,6 mln euros and include: flood protection 75 million euros, energy production 0,34 million euros, water for drinking and other human needs 1,23 million euros, recreation and tourism 11,64 million euros (the benefits from recreation are included in the analysis as a fixed sum of land appreciation in 2009), benefits to agriculture 0,33 million euros and fisheries 0,06 million euros.(BBF 2003)

The environmental and social costs and benefits were not included in this economic analysis, many of which are difficult to estimate. The costs discussed in the report included environmental impacts, relocating communities and reductions in biodiversity. It should be noted that 527 species and 37,8% of flora in Wielkopolskie are on a red list of endangered species (Zukowski and Jackowiak 1995). In addition, other possible and un-quantified costs include changes in the hydrological regime and microclimate, barriers for the migration of fish and other organisms, changes in water dependent ecosystems, silting, reducing downstream groundwater, and loss in self-cleaning abilities of the water.

[1] applied exchange rate 1 EUR = 4 PLN applied exchange rate 18.09.2012 http://www.xe.com/ucc/convert/?Amount=1&From=EUR&To=PLN

The reservoir construction is contested by the local communities, and there also appears to be weak political will on the part of the regional policy makers and water authorities to complete construction. Many observers suggest that the construction may be stalled due to public protest, and unresolved issues regarding compensation for those now living in the area to be inundated (BBF 2003). The stakeholders at the RESPONSES workshop took the view that such projects will have macro-scale benefits, but impose large losses on the local population.

The European Commission is strongly supporting this project. In the first economic and feasibility study the €73.9 million reservoir construction cost was planned to be financed from the Cohesion Fund (€44.1 million – 60%), National and Regional Funds for Environmental Protection and Water Management (€22.2 million – 30%) and regional government funds (€7.6 million – 10 %).

Taking account of climate change in the Wielowieś Klasztorna reservoir analysis

The Wielowieś Klasztorna reservoir is expected to contribute to climate adaptation by reducing the risks of drought, and especially flood. In fact, over 50% of the benefits from the reservoir are attributed to flood protection (77 million euros flood losses avoided in 2010).

Flood protection is thus a major benefit of the project, dwarfing energy production, which is estimated at about 0,38% of the benefits, or 0,34 million euros annually. It is instructive to understand how flood risk reduction was estimated, and whether climate change was taken into account.

4.1.1.2 *Flood risk assessment*

The flood protection benefit was based on one selected flood scenario (S1), that is, the 100-year flood in 2010. Other flood scenario estimates included:

S1: the reservoir is expected over thirty years to reduce the losses from one selected major flood (2010) equal to 75 million EUR[2]. NPV= 11.5 million EUR, Internal Rate of Return (IRR)= 8,1%

S2: the reservoirs allows for flood losses avoided in the year 2020 at the level of 75 million EUR. NPV= --7.1 million EUR, IRR= 4%

S3: the reservoirs allows for flood losses avoided in 2010 at the level of 90 million EUR. NPV= 21.2 million EUR, IRR= 10,6%

S4: the reservoirs allows for flood losses avoided in 2010 at the level of 60 million EUR. NPV= 1.8 million EUR, IRR= 5,5%

S5: no flood; NPV= -36.8 million EUR,

[2] Applied exchange rate to calculations: 1 EUR= 4 PLN

Note that more advanced methods are available for including flood risk in CBA calculations by considering the whole range of flood risk probabilities (Mechler 2008).

4.1.1.2 *Including climate change in flood risk assessment*

The Wielowieś Klasztorna analysis did not consider climate change in the cost-benefit analysis. The reason suggested in expert interviews was that in the planning period for water investments, it is not expected that climate change will have a significant influence on flood risk

The FD and the Common Implementation Strategy (CIS) for the WFD state that uncertainty related to *climate change* should be presented transparently in flood maps, and climate change scenarios included in ongoing initiatives and in planning processes. Guidance has been given on including climate change for planning purposes in the EC document, "River basin management in a changing climate - a Guidance document". In the RBMPs for Vistula and Oder, however, it is stated that for the first planning cycle of the WFD the foreseen climate changes will be of very little importance to impacts for actions identified in the plans. The increase of temperature of 2 degrees in the country is probable only in the second half of the 21st century. It is expected that within the time frame of WFD implementation (till 2027) a climate change signal will thus not be statistically distinguishable from the effects of other human pressures. This does not mean that the Oder RBMP did not discuss possible climate change in the basin. Historical hydro-meteorological conditions were described together with prognoses for the future climate. It was concluded that due to increasing precipitation and frequency of convectional cloudiness, there would be an increased frequency of floods, intensive rainfall and drought periods.

In Deliverable 4.5 we will examine the CBA for Wielowieś Klasztorna, and compare the results with other options for water retention including micro-reservoirs, afforestation, shelter belts and conservation tillage, in the Warta region.

4.1.2 Policy option 2: intensify EU support for on-farm water retention measures

In this section, we describe a second, although not necessarily an alternative, policy option for the Commission: intensifying support for on-farm water retention measures. We select three (from many) potential measures for our focus: micro reservoirs/wetlands, on-farm afforestation (shelter belts) and conservation tillage practices.

4.1.2.1 Micro-reservoirs in the Warta region

Micro-reservoirs or ponds, as described in section 2.1.2, can be located both within the floodplain and in higher elevations of the catchment as a means to retain water, especially for agricultural purposes. Currently, over a ten-year period (2005 to 2015) some 284 **off-farm** ponds, averaging about two hectares (20,000 m2) in size and covering up to 80 (800,000 m2) hectares in area, have been or will be constructed in the Wielkopolska Voivodship under the jurisdiction of the Amelioration and Water Facilities Management Board (WZMiUW) and supported by the EU Rural Development Programme, Regional Operational Programme for Wielkopolskie (under the Programme for the Oder). They are also supported by

the, Fund for Protection of Agricultural Land, the regional and local government budgets, the National Fund for Environmental Protection and Water Management, Regional Fund for Environmental Protection and Water Management (Source: Amelioration and Water Facilities Management Board (WZMiUW) 2011) These ponds in total would provide over 12 million cubic meters of water storage capacity (compared to 48.8 million expected from the Wielowieś Klasztorna reservoir). They would contribute importantly to water retention in higher zones beyond the hydrological influence of the major rivers (BIPROWODMEL 2005). They also have co-benefits in terms of bio-diversity and climate mitigation, specifically the cooling of the micro-climate and the raising of groundwater levels in the pond's vicinity.

One example of an **on-farm** smaller-scale water storage infrastructure is provided by two small reservoirs constructed privately on a relatively large (1500 ha) farm in the Struga Śledzka Valley. The two ponds total 70 ha in area (700,000 m2) and can store up to 500 000 cubic meters of water. Because the ponds are significantly greater than 100 m2 (1 ha = 10,000 m2), they would not qualify for an EU subsidy; to the contrary, if they replace cultivatable land, they will reduce the farmer's area payment. The fact that water scarcity has historically led to complete dry-down of these reservoirs illustrates the gravity of drought potential in the region. To lower drought vulnerability this storage capacity is integrated into an irrigation system consisting of 24 km underground aqueducts, 12 valves, 6 pumping stations, and 16-18 sprinklers. The irrigation was usually performed for the entire farm using 100 000 m^3 water per 400 ha (Interview with Stefan Jankowiak, a farmer from the region).

EU policy on micro-reservoirs

The CAP Health Check has established new Good Agricultural and Environmental Practices related to water standards. These include, for example, the *establishment of buffer strips along water courses* (1.01.2012) and compliance with authorization procedures for irrigation where applicable (due 1.01.2010). Poland's "Code of Good Agricultural Practice" (Duer et al. 2004:72) adds to these requirements and states that farmers should maintain drainage installations and infrastructure as well as perform anti-soil erosion practices, re-cultivation of areas deteriorated after natural disasters, *designate locations on private land for technical infrastructure, such as ponds, small water retention reservoirs for flood protection and future production purposes.* As we see on Figure 2.5, many if not most practices that reduce the risk of flood and drought can be required as a cross compliance condition.

Although the Commission's proposals will likely change strategy, at this time *there are no specific strategic documents linking CAP to flood and drought risk management or adaptation practices at the national and local levels.* The AEM did not explicitly incorporate measures for flood and drought risk management, nor for climate policy; yet, it set the stage for later reforms that would take these concerns into account. Inadvertently, the strategies address flood and drought risk. For instance, farmers are and can be paid for maintaining pastures instead of cultivating crops, a substitution that increases water absorption and thus decreases downstream risks of flooding. In addition, farmers can receive agri-environmental payments for constructing very small ponds (under 100 m^2 in area) that compensates them for their area payment reduction based on

cultivated land. The Commission currently proposes a basic income support to replace single farm payments, which would remove this disincentive. The Commission's CAP reform proposals can shift additional support for micro-reservoirs. The proposal is to place a greater emphasis on environmental measures, with up to 30% of the funding granted to the improved use of natural resources. These measures include what is already supported by AES and cross compliance measures, for instance, crop diversification, maintenance of permanent pasture and the preservation of environmental reservoirs and landscapes. As *more funds will shift to these so-called 'green payments', there is great potential for support for flood/drought management and thus to climate adaptation and mitigation.*

Stakeholder views

The stakeholder interviews (and later the workshop discussions) revealed that many farmers are strongly motivated to reduce their risk of flood and drought, and some report concern that these risks are increasing due to climate change. At the same time, many farmers show no pattern of strategizing for securing stable water supplies, e.g. building on farm water storage for their crops in an uncertain future. Rather they focus on strategies that maximize short-term profitability (Kozyra 2012). Stakeholders also reported farmer awareness of possible measures and their benefits and costs as key factors in implementing EU policies, and a problem area that has been given relatively little attention.

4.1.2.2 Afforestation/shelter belts

Most efforts for re-establishing forest on agricultural land, as discussed in Section 2.1.4, are carried out by the Polish state, which manages 78% of forests in Poland (an additional 4% are managed by the national parks). The remaining 18% are private forests. In 2004 a farmland afforestation support system was introduced within the framework of the Rural Development Plan (RDP), funded within CAP from the European Agricultural Fund for Rural Development (EAFRD). With 80% financial support provided by the EU and 20% from Polish funds, tens of thousands of hectares of farmland were afforested between 2006 and 2008 in conjunction with large-scale educational campaigns on afforestation for farmers. Wielkopolska experienced a decrease of forest cover between 1989 and 1995; yet, from 1995 to 2005 afforestation resulted in net annual gain of some 1416 hectares.

Shelterbelts are part of Polish efforts for creating more forest areas on farmland. Shelterbelts, described in Section 4.3.3, are composed primarily of trees and shrubs that are often intentionally planted to line the margins of roads, agricultural fields and waterways. They have a wide range of benefits, including buffering temperature extremes and increasing evapo-transpiration rates. A mosaic of landscape structures including small, cultivated fields, shelterbelts, meadows and small ponds increases water retention capacity and maintains biological diversity of mammals, amphibians, reptiles, and insects. In particular, the number of bird species is positively correlated with the diversity index of the landscape (Ryszkowski, 1995).

EU policy on afforestation/shelter belts

As mentioned above, the CAP EAFRD (Afforestation of Rural Areas 1257/1999-EU Council Directive) directly subsidizes reforestation efforts on the part of private landowners (EU sponsorship does not cover communal land). The EAFRD, however, does not provide subsidies for trees planted for shelter belts, which is covered by the AES. Besides the EAFRD, we note that the CAP area payments could require shelter belts and other forms of afforestation as a cross-compliance requirement. As mentioned earlier, the Polish "Code of Good Agricultural Practice" (Duer et al. 2004, p. 72) requires that farmers undertake anti soil-erosion practices. The Code addresses shelter belts and provides guidance on tillage, for example, through recommended good practices: " …planting and maintenance of belts of trees or shrubs between plots of arable land" (p.45), when soil is especially endangered by wind erosion, no-tillage is recommended" (p. 45), " Tillage should be done as much as necessary and at the same time as little as possible" (p. 47). No-tillage is recommended especially on for cultivation of fields where the gradient or slope can cause rapid runoff (p. 44). Without this requirement, the area payments can actually reduce incentives for private afforestation measures since area-based payments to farmers are proportionally higher for arable land versus forest land. Dzikowska et al. (2006) note that afforestation rates might well increase should policy reform close the gap between afforestation and agricultural subsidies and increase educational campaigns to raise the ecological awareness of farmers.

The Commission's proposed CAP reforms would eliminate this gap by eliminating single farm (and area-based) payments in favor of a farmer income support. It should also be noted that the proposed reform would strengthen the provision of agri-environment schemes, which would *contain an additional focus on climate change mitigation and adaptation.* Finally, the Commission has clearly voiced its intent to encourage measures such as shelter belts with its new priorities for the Rural Development Program, one of which is "restoring, preserving and enhancing ecosystems depending on agriculture and forestry". Farmers in the Warta region did not receive support payments for adopting no-tillage or shelter belts, but this may be primarily because they did not apply for EU support for such measures. Along with the Research Center for Agricultural and Forest Environment, Poznań. Polish Academy of Sciences, one farmer did receive money from the Regional Fund for Environmental Protection and Water Management to plant shelter belts. However, this funding was to support a scientific pilot project to study the introduction of shelter belts. SOURCE (Kedziora 2012).

Stakeholder views

At the RESPONSES workshop on "Adaptation to flood and drought risk in the Warta water region: the role of the European Union," participants highlighted afforestation as one of the measures that is least frequently applied in the Warta catchment, but a measure with great promise. They indicated multiple benefits from afforestation, including the increase in rainfall of 5 mm per 1% increase of forest area, increase in water retention capacity of land, increase in the minimum water flow during times of water stress, slowing flood flows/waves, production of oxygen, CO2 sequestration, and restricting of soil erosion, among others. According to regional stakeholders, the barriers to afforestation in the region include the regional priority given to agricultural development, the ineffective and inflexible

regulation of afforestation by a centralized state plan, the insufficient amount of space designated by municipalities for reforestation, the difference in subsidy levels between arable land (which receives more subsidies) and forest land, and finally that income from forest areas is delayed by a few decades.

4.1.2.2 Conservation tillage

As described in Section 2.2.1, the threat of wind erosion to Wielkopolska's light soils is aggravated by the traditionally intensive agricultural production and soil tillage, which has also increased drought risk by contributing, among other things to a net loss in the region's water balance. To counter these latter negative effects, conservation tillage practices have been developed that sustain much higher rates (30 to 100 percent) of crop cover year round. Minimizing tillage can lower the impacts of wind erosion, and, hence, evapo-transpiration that contributes to relative water scarcity. In addition, the higher crop cover densities help lower flood risk in a variety of ways. It slows water movement by reducing direct water impact on bare soil, by slowing water movement on the surface and encouraging greater rates of infiltration to the soil and percolation down to the groundwater level, and by increasing the density of organic material both above and below ground and thereby enhancing carbon storage and water absorption and retention in the soil itself.

EU policy on conservation tillage

In principle, tillage practices could potentially be a part of the agri-environmental program, but it has not been mainstreamed into the conventional set of agricultural practices.

It appears that the intent of the Commission's proposed CAP reforms would promote conservation tillage insofar as it can be shown to be a measure with high benefits compared to its costs to farmers. We noted in Section 3.2.3 that the axes of the Rural Development Program have been replaced by six priorities, including p*romoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sectors.* Since changing traditional tillage practices will require a strong shift in farmers' knowledge and attitudes, it is relevant that the six priorities also include "fostering knowledge transfer and innovation in agriculture, forestry and rural areas".

Stakeholder views

The conservation tillage (no- or less-tillage) measure was rated higher than afforestation by the Warta basin stakeholders as being infrequently applied in the Warta catchment, but a measure that should be applied more frequently. It is seen as a currently uncommon, but for some stakeholders it is a promising practice that can impact flood and drought adaptation, by others it is considered of marginal importance for mainstream farming (Dubel 2012b) The benefits from a no-tillage agro-techniques according to participants in the RESPONSES workshop include: increase of agricultural yields, more stable yields, higher soil retention, increase of decay in the soil (fertilizer for future crops), increase of CO2 sequestration (estimated by stakeholders to be about 36 Mg CO2/1ha), increase of biodiversity (especially soil organisms), increased biologic activity of the soil as well as saving fuel and man-month costs, and an increase of jobs in equipment production.

The most important barrier related to region-wide application of conservation tillage, according to stakeholders, is tradition. Polish farmers have traditionally tilled their land, and believe that plowing results in high yields. Other barriers listed by the stakeholders include: lack of education of farmers, the long process of changing attitudes and equipment, poor transfer of knowledge (lack of appropriate research projects), the traditional stereotypes in science, lack of studies on the use of fertilizers in no-tillage farming.

5 Summary and next steps

5.1 Summary

In this deliverable, we have discussed and provided insights on the following questions:

As an adaptation measure, what are the potential agricultural and water management measures for reducing flood and drought risk in the Warta region?

A large variety of agricultural and water management measures can reduce the risks of flood and drought in temperate climates such as that found in Poland, and thus contribute to climate change adaptation. We have identified over 50 measures classified as public "off-farm", private "on-farm" and "market" measures, with particular attention to those that are currently topical in the Warta region of Poland. We have discussed the contribution of Warta's agricultural and water practices for adapting to flood and drought risk reduction and also for mitigating climate change. Of particular interest is the past and current priority of investing in large and medium-scale reservoirs, primarily as a flood prevention measure, and the current interest in small reservoirs and other on-farm measures that retain water in the landscape. On-farm measures can contribute (perhaps significantly), not only to reducing drought and flood losses, but also to climate change mitigation, biodiversity and other environmental services.

How does the EU support, regulate and provide guidance for these measures?

The EU has in place a strong portfolio for funding, regulating, and guiding agricultural and water policy for reducing the risks of floods and droughts, and thus supporting adaptation to climate change. In some important cases, most notably afforestation and conservation crop tillage, these measures also have potential to contribute to climate change mitigation. The recent Water Framework Directive, and especially the Flood Directive, are giving strong signals for Member States to assess and manage flood risk, although Polish authorities have to date given little emphasis to the EU Water Scarcity and Droughts Strategy. Still, in the Warta, there is concern that existing water planning practices (mainly supply-oriented) may prove inadequate to cope with the adverse impacts of drought, leading to overexploitation of water bodies.

The structural and cohesion funds and the CAP European Agricultural Fund for Rural Development (EAFRD) are the two largest sources for funding agricultural and water projects. A sizeable part of these funds have financed public, off-farm projects, like reservoirs, levees and polders, which have been targeted mainly to reducing flood risk, but which may have fewer co-benefits with regard to climate change mitigation and the support of biodiversity than their on-farm counterparts (this will be examined in Deliverable 4.5).

A number of EU policies, and their implementation by Polish authorities, provide disincentives for climate change adaptation and mitigation. Most notably, CAP's area farm payments, which subsidize arable land more than forested land, discourage such measures as shelter belts and micro-reservoirs (greater than 100m2), both important for adaptation and mitigation. The Polish policy of exempting surface waters used for irrigation from water pricing (thus offering

public waters free of charge) also discourages farmers from investing in water retention measures, such as small reservoirs and conservation tillage practices. As a final example, while the EU requires extensive crop insurance, the polish implementation of this requirement with heavy public subsidies also lessens incentives for farmers to take on privately funded risk reduction measures.

With the latest CAP "health check", an important opportunity exists to finance smaller, on-farm measures that contribute to adaptation by retaining water in the landscape and thus reducing flood and drought risk, and also to mitigation by sequestering CO2 in soils and woodlands. The Commission's proposed reforms to CAP will also eliminate the disincentives deriving from area farm payments, and shift more funds to so-called 'green payments' with great potential for support for integrated and robust flood and drought risk management measures, like small reservoirs, afforestation and conservation tillage, that not only contribute to climate change adaptation but also to mitigation.

How are the potential impacts of climate change on flood and drought risk taken into account in assessing these measures? How are the contributions of these measures on climate change mitigation accounted for?

The Flood Directive and the Common Implementation Strategy (CIS) for the Water Framework Directive state that uncertainty related to climate change should be presented transparently in flood maps, and climate change scenarios included in ongoing initiatives and in planning processes. According to the EU's Climate Change & Water Guidance document, it is expected that climate change will be fully integrated into river basin management for the 2nd and 3rd RBM cycles. In the RBMPs for Vistula and Oder, it is stated that for the first planning cycle of the WFD the foreseen climate changes will be of very little importance to impacts for actions identified in the plans. This was reflected, for example, in the cost-benefit analysis carried out for the Wielowies Klasztorna reservoir (planned for completion in 2015), which did not take climate change into account. Moreover, this CBA did not consider the relation of the reservoir to climate change mitigation.

Although many analyses have been carried out for large infrastructure projects, we have not identified analyses that examine on-farm measures for the purpose of retaining water. This is an important gap given that in many cases on-farm water retention measures have the co-benefit of sequestering CO2 and supporting biodiversity.

What measures are particularly robust for addressing climate-related drought and flood risks, and how can they be assessed?

The IPCC report on extremes (SREX) noted the difficulties of determining the contribution of climate change to current flood and drought risk, and even estimating attribution in the future. Notably, with respect to floods, even the sign of the future change may be indeterminable at this time. Because of this uncertainty, it is important to explore robust solutions to the flood and drought problem. One such solution is increasing water retention in rural areas, which is important both for increased dry periods (droughts) and, because it lowers risk to urban areas, for increased wet periods (floods). We have identified four water retention measures for our continued analysis. These include the public construction of medium/large reservoirs, the private construction of micro-scale

reservoirs, and on-farm practices of afforestation (including shelterbelts) and conservation tillage.

The extent to which the Commission emphasizes on-farm water retention measures should depend to a large extent on their costs and benefits compared to off-farm water retention measures. This will be the subject of Deliverable 4.5.

5.2 Next steps: policy option evaluation

As this discussion has shown, the WFD, FD and latest proposed CAP reforms have set the stage for funding, regulating and guiding agricultural/water policies, especially on-farm measures, that would promote "green" objectives and specifically adaptation and mitigation to climate change. Yet, there are surprisingly few analyses of on-farm measures that assess their benefits and costs. The objective of Deliverable 4.5 will be to evaluate two EU agricultural/water policy options that have been identified as particularly relevant to climate adaptation and mitigation in Poland and throughout many Member States. Both options are aimed primarily at retaining water in the landscape with the primary benefit of reducing flood and drought risks, but with secondary benefits and costs, including mitigation of climate change. The selected options include: (1) a continued policy of strong support for large reservoirs, and (2) increased and intensified support for on-farm water retention measures, including small reservoirs, afforestation and conservation tillage.

The questions we will address in Deliverable 4.5 include:

- What are the relative costs and benefits of these measures with respect to their primary purpose of retaining water in the landscape, and thus reducing drought and flood risk (adaptation)?
- What are their co-benefits in terms of climate mitigation, and also other aspects, such as improving bio-diversity, electricity generation, tourism, etc?
- How does (and should) climate change enter the cost and benefit estimates?
- Based on the costs and benefits of these measures, should the EU (and Polish authorities implementing EU policy) consider changing priorities with regard to the two policy options?

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Appendix I

Interview date	***Name***	***Affiliation***
29.February 2012	*Prof. Andrzej Kędziora*	*Institute for Agricultural and Forest Environment (IAFE) of Polish Academy of Sciences in Poznań*
29.February 2012	*Prof. Zbigniew Kundzewicz*	*Institute for Agricultural and Forest Environment (IAFE) of Polish Academy of Sciences in Poznań*
29.February 2012	*Albert Mailinger*	*Institute of Meteorology and Water Management, Division in Poznan, Regional Modelling Center*
29.February 2012	*Radosław Pasiok*	*Institute of Meteorology and Water Management, Division in Poznan, Regional Modelling Center*
28.March 2012	*Dr Jerzy Kozyra*	*IUNG, Puławy*
28.March 2012	*Prof. Janusz Kindler*	*Warsaw Polytechnics, Warsaw*
11.April 2012	*Prof. Janusz Zalewski*	*European Regional Ecohydrology Center, UNESCO*
11.April 2012	*Katarzyna Marks*	– WWF Polska, specialist in energy and cli mate policies
11.April 2012	*Dr Marzena Osuch*	Institute of Geophisics Polish Academy of Science in Warsaw
12.April 2012	*Ryszard Jaworski*	*Regional Agricultural Advisory Center*
12.April 2012	*Prof. Janusz Jankowiak*	*Institute for Agricultural and Forest Environment (IAFE) of Polish Academy of Sciences in Poznań*
12.April 2012	*Prof. Piotr Kowalczak*	*Institute for Agricultural and Forest Environment (IAFE) of Polish Academy of Sciences in Poznań*
12.April 2012	*Wojciech Białek*	*Regional Water Management Board in Poznan*
12.April 2012	*Stefan Jankowiak*	*Jagrol Prezes [farmer, manager]*
13.April 2012	*Arkadiusz Błochwiak*	*Amelioration and Water Facilities Management Board*
13.April 2012	*Henryk Ordanik*	*Agricultural Corporation Karolew [farmer]*
13.April 2012	*Andrzej Szumski*	*Department of Agriculture Forestry and Environmental Management of Local Government (Gostyń County)*
13.April 2012	*Ryszard Sziwa*	*Institute of Meteorology and Water Management, Division in Poznan*

Appendix II

List of the "Adaptation to the flood and drought risk in the Warta water region - the role of the EU" Workshop participants, held on the 30.05.2012

No	Name	Function	Institution
1.	Mgr Arkadiusz Błochowiak (represented by Michał Szmiński)	Director	Amelioration and Water Facilities Management Board
2.	Mgr Henryk Ordanik	Head of an agricultural Corporation	Agricultural Corporation Karolew [farmer]
3.	Mgr Andrzej Szumski	Head of Department	Department of Agriculture Forestry and Environmental Management of Local Government (Gostyń County)
4.	Mgr Paweł Kurosz	Director	Department of Crisis Management and Social Security of Local Government (Poznań County)
5.	Mgr Dariusz Krzyżański (represented by Wojciech Białek, Jacek Smusz)	Director	Regional Water Management Board in Poznan
6.	Piotr Łykowski	Director	Agency of Restructuring and Modernization of Agriculture
7.	Dr Tadeusz Przybecki	Head of Department	Agricultural Advisory Center for Wielkopolska in Poznan
8.	Mgr Mariola Górniak	Director	Marshall Office, Department of Environment
9.	Dr Jerzy Kozyra	Researcher	Institute of Soil Science and Land Cultivation,

No	Name	Function	Institution
			State Reseach Institute, Puławy
10.	Mgr Ryszard Sziwa	V-ce Director	Institute of Meteorology and Water Management, Division in Poznan
11.	Prof. Andrzej Kędziora	V-ce Director	Institute for Agricultural and Forest Environment (IAFE) of Polish Academy of Sciences in Poznań
12.	Prof. Janusz Jankowiak	V-ce Director	Institute for Agricultural and Forest Environment (IAFE) of Polish Academy of Sciences in Poznań
13.	Dr Marzena Osuch	Researcher	Institute of Geophisics Polish Academy of Science in Warsaw
14.	Mgr inż. Agnieszka Banrowska	Researcher	Institute of Geophisics Polish Academy of Science in Warsaw
15.	Dr Monika Kaczała	Researcher	Department of Insurance, University of Economics in Poznan
16.	Dr Łyskawa Krzysztof	Researcher	Department of Insurance, University of Economics in Poznan
17.	Dr Piotr Mańkowski	Researcher	Department of Insurance, University of Economics in Poznan