IMPLEMENTATION OF FLOOD DIRECTIVE IN POLAND IN THE CONTEXT OF FLOODPLAIN DEVELOPMENT

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Manuscript received: October 13, 2013
Revised version: February 17, 2014

GŁOSIŃSKA E., Implementation of Flood Directive in Poland in the context of floodplain development. Quaestiones Geographicae 33(1), Bogucki Wydawnictwo Naukowe, Poznań, pp. 23–37, 4 figs, 4 tables. DOI 10.2478/quageo-2014-0002, ISSN 0137-477X

ABSTRACT: The Flood Directive (FD) aims *to establish a framework for the assessment and management of flood risks, aiming at the reduction of the adverse consequences for human health, the environment, cultural heritage and economic activity* (FD, Art. 1). The implementation of Directive is a multi-stage process, with the defined deadlines for the completion of each stage. The main aim of the paper is to present the process of Flood Directive implementation in Poland, including the present state of works on the implementation of particular stages. The evaluation of the significance of Directive implementation in Poland will also be presented.

KEY WORDS: Flood Directive, flood hazard, flood risk, spatial planning in floodplains, Poland

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Introduction

They are the floods that are regarded to be the one of the most dangerous natural hazards for societies, e.g. (WBGU 1999, Schanze 2006). They may cause great material losses and, what is worse, loss of human life (Toya 2007). The existence of these natural and anthropogenic extreme phenomena around the world let us pay greater attention on their environmental and economic consequences (Guzzetti *et al.* 2005, Schmidt *et al.* 2006, Lerner 2007). An increase of catastrophic events, ending up with high number of fatalities and material losses has been observed in recent years (Steinführer 2008, Walczykiewicz 2002, Luino *et al.* 2012). Therefore the discussion about the European Flood Protection Policy has been undertaken (Steinführer 2008).

A protection of people and their properties from flood is a significant challenge for European countries as continuous intensification of development in floodplain areas takes place. Thus increase of flood losses that have been observed in those countries in recent decades results mostly from human activities in the floodplains (Luino *et al.* 2012). The development of floodplain areas may also cause the increase of flood protection costs, especially when it comes to the urban areas threatened by flooding (Waananen *et al.* 1977). The growth in the number of people affected by floods and increase of economic losses indicates clearly the increase of flood risk (compare Schanze 2012). It should be also emphasized, that the development of floodplains causes the decrease in surface retention of water and its increased surface flow (CA WALUP 2009, Ristic *et al.* 2012,

Saul *et al.* 2007 after Harvey *et al.* 2009). In order to stress the nature-related significance of floodplains, they have been defined by the Directive as *natural retention areas*.

During the first decade of International Decade of Natural Disaster Reduction (IDNDR) activity (between year 1990 and 1999) it was noticed that former flood protection paradigm was improper (UNDRO 1991, Plate 1998). It was stated that metaphorically speaking (acc. Aubrecht *et al.* 2009, 2011) *raising flood embankments* couldn't be the only answer for growing flood risk problem. Nowadays, governmental policies of particular countries depart their conception on flood protection from categories of control and defense into giving rivers their space back, predicting and managing of flood risk, indicating flood risk factors (e.g. Turner *et al.* 1998, NDRC 2007, DETR 2000, Evans *et al.* 2002, Burton *et al.* 2003, Thorne *et al.* 2007). Then flood protection policy, new and more beneficial idea of risk management has been introduced (Plate 1999, Schanze 2012, Hall *et al.* 2003, Hooijer *et al.* 2004, Steinführer 2008, Schanze 2006).

Flood risk management deals with wide spectrum of issues, starting from flood risk forecasting, through social, economic and ecological effects of flood finishing on resources and instruments of risk reduction (compare Schanze 2006). It involves all flood risk cycle including flood prevention, protection and preparation, response for floods and emergency management. It also comprises restoration of flooded areas and draws a conclusion in course of floods (Steinführer 2008).

The Flood Directive stated by the European Union in year 2007 is an expression of comprehensive approach to issue of growing flood risk. It is the Flood Directive that set up a framework for flood risk management. It is also the answer for answer to the problem of development and building up natural floodplains. At the beginning of Flood Directive it is stressed that *(...) increasing human settlements and economic assets in floodplains and the reduction of the natural water retention by land use (….) contribute to an increase in the likelihood and adverse impacts of flood events*. By stating this Directive draws attention to the significance of the forms of floodplains development

The main aim of this paper is to present the process of implementing the Flood Directive in Poland, considering its current stage of implementation and defining the influence of introduced legislative changes on the future development of floodplains. The evaluation of the significance of the Directive implementation will also be presented.

Flood Directive and stages of its implementation

The Flood Directive was adopted by the European Parliament and the Council of Europe in 2007 due to the increasing level of flood risk caused, among others, by climate changes and land development policy in the area of floodplains. The document is of a framework nature and aims to define general standards of hazard identification, risk assessment and undertaking preventive measures which would minimize flood-related loss.

The Directive also aims to improve information exchange concerning the river basin areas, including international basins, as well as undertaking appropriate actions in terms of spatial planning and the development of floodplains (Kitowski 2010). The Directive concerns not only riverside areas, but also internal sea waters, which, however, are not the subject of this paper.

The Flood Directive aims *to establish the framework for the assessment of flood risk and for its management in order to minimize negative consequences for human health, the environment, cultural heritage and economic activity* (FD, Art. 1). In this connection, it introduces the concept of *flood risk* understood as *the combination of the probability of a flood event and of the potential adverse consequences for human health, the environment, cultural heritage and economic activity associated with a flood event* (FD, Art. 8). Another important concept in the Directive implementation is the concept of flood hazard, understood as *potential range of flood which occurred in the past or was determined based on statistical mathematic calculations, presenting the water rise with determined occurrence potential* (Kitowski 2010: 49).

The implementation of Flood Directive in the EU member states is a process consisting of five stages with determined implementation dates. The stages comprise:

1. adjusting the law of a member state (by 26 November 2009),

2. elaborating the Preliminary Flood Risk Assessment (by 22 December 2011),
3. elaborating the maps of flood zones (by 22 December 2013),
4. elaborating the maps of flood risk areas (by 22 December 2013),
5. preparing plans for flood risk management (by 22 December 2015).

The EU member states are obligated to meet all the requirements of the Flood Directive by the end of 2015.

State of advancement of Flood Directive implementation in Poland

Poland, similarly to other EU states, has successfully completed the four first stages of Flood Directive implementation as of February 2014 (Table 1).

The first stage of Directive implementation in Poland involved adjusting the Polish law to the requirements of the Directive that is including its stipulations in the Polish legislation. This stage was completed with over a one-year delay, at the beginning of 2011 by passing a law[1] which imposed many changes in Polish legal acts, among others in the Water Law and the Law on spatial planning and development. As a result of legislative implementation of the Directive, the terminology of particular types of floodplains has been changed (Table 2). The areas at direct hazard of flooding have been called the areas at special hazard of flooding. The proper term of *areas at potential hazard of flooding* has been removed; however, these areas are still determined and described as areas threatened by flooding as a result of water overflowing the top of levee. The novelized Water Law defines the way of determining particular classes of floodplains, assign-

Table 1. Stages of Flood Directive implementation in Poland

Implementation stages	Form of implementation/content of studies
ADJUSTMENT OF LAW Completed	Adopting the Regulation of 5 January 2011 on changing the Water Law and several other acts of law, including the Spatial planning and development act.
PRELIMINARY FLOOD RISK ASSESSMENT Completed	Describes the areas of flood hazard – areas in which significant flood risk occurs or significant flood risk is probable to occur
FLOOD HAZARD MAPS for the areas exposed to flood hazard Completed	Determine among others: – areas with low probability of flood occurrence – once in 500 years, or areas with the probability of extreme event – areas of special flood hazard – areas where the probability of flood occurrence is: – medium – once in 100 years – high – once in 10 years – and areas between the riverline and flood levee or a natural high bank with the levee line built in, as well as islands and alluvions – areas threatened by flooding in case of water overflowing the top of levee, or in case of destroying or damaging levees, or destroying and damaging damming structures
FLOOD RISK MAPS for the areas of direct flood hazard Completed	Define among others: – number of inhabitants exposed to flood risk – types of business activity – installations posing the risk of environment pollution
FLOOD RISK MANAGEMENT PLANS for river basins and water regions (by 22 December 2015)	Define among others: – borders of areas exposed to flood hazard – maps of flood risk and flood hazard – aims of flood risk management and list of activities aiming at achieving the results

Source: based on Flood Directive (FD 2007) and Water Law.

[1] Act of 5 January 2011 on the amendment of Water Law and some other acts (Journal of Laws [Dz. U.] No. 32 item 159).

Table 2. Classification of floodplains (areas exposed to flood hazard)*

Floodplain classes	
before	after
legislative implementation	
Areas requiring protection from flooding due to their land development and cultural and economic value (with floodwater occurrence probability of at least once in *200 years*)	Areas in which the probability of flood occurrence is *low*, it is once in *500 years* or in which there is a possibility of *extreme event*
Areas at direct hazard of flooding – *the zone of flood wave* determined in the land use planning based on a flood protection study; areas between the river line and flood levee or a natural high bank with a build-in flood levee, as well as islands and alluvions (*inter-embankment zone*)	Areas at special hazard of flooding – areas in which the flood hazard is: – medium, once in 100 years – high, once in 10 years and areas between the river line and flood levee or a natural high bank with a build-in flood levee, as well as islands and alluvions (*inter-embankment zone*)
Areas at potential hazard of flooding – areas at risk of flooding in case of water overflowing the levee top, destroying or damaging flood levees, destroying or damaging damming structures	Areas exposed to the hazard of flooding in case of water overflowing the levee top, destroying or damaging flood levees, destroying or damaging damming structures

*The table does not include the sea-coast technical belt.
Source: based on the novelized Water Law.

ing to them the exact probability of floodwater occurrence. This solves the problem of selecting from among many flood lines determined in *former* flood protection studies[2], the one appropriate for spatial development planning.

As a result of the Directive implementation, the list of bans on land development and management of floodplains has not been changed. This means that in the areas at special hazard of flooding, bans and restrictions from the *former* areas of direct flood hazard are binding, including the ban on land development[3]. The restrictions upon the river embankments development and their vicinity have also been kept[4]. There is also the possibility of lifting these bans in the areas of special flood hazard under the decision of the Head of Regional Water Management Board (HRWMB), on the condition that it would not impede flood protection. Also the Marshal of the Voivodship may revoke existing prohibitions that concern to levees, if only this decision doesn't have negative impact on tightness and stability of the embankments.

The great advantage of the introduced changes is that the territorial range of introducing bans on land development and management in the areas of special flood hazard has been broadened, including a ban on land development, and other areas have been comprised, that is not only the areas beyond the line of flood levees (*former* areas of potential hazard of flooding), but also ones for which flood risk level has not been defined.

Above all, the deadlines for elaborating maps of flood hazard and risk and deadlines for having all these maps included in planning documents[5], comprised in the novelized Polish legislation ensures their execution and implementation to the spatial planning. The elaboration of flood protection studies has been optional so far and their arrangements (including ban on buildings) have

[2] The study of flood protection is a cartographic study including text, elaborated based on the old Water Law (prior to novelization), in which the borders of areas at direct flood hazard, and sometimes the areas of potential flood hazard, were determined. The borders of these floodplains were included in the spatial development plans.

[3] In the direct/particular flood hazard areas all works and other activities that may hinder the flood protection are forbidden, inter alia, prohibition on construction of building, planting trees and shrubs, the landform change and the materials stockpiling.

[4] To ensure the tightness and stability of river embankments it is prohibited, inter alia, to drive through the levees or along their crone, cultivate the crops, to plant trees and shrubs both on the river embankments and within 3 meters from their base on the land-side and to construction of building within 50 meters from the embankment's base on the land-side.

[5] As flood hazard maps are delivered to institutions that are responsible for preparing spatial development plans these institutions have 18 months to make all changes depicted in these maps to valid area development plans.

not been commonly applied. Only after an extent of areas at risk, delineated in the Study of Flood Protection, is included in the area development plans (which are municipal acts of law) restrictions and prohibitions given by HRWMB for spatial development of flood hazard areas may be respected. Local land management plans usually hasn't included the range of flood hazard so far, which resulted in the development of land situated directly along water courses.

It should be stressed that an implementation of the Flood Directive in Poland let authorities to develop strict procedures upon issuing the decisions on the exemption from the development ban in floodplains which do not allow for including such areas in the procedure of local land development planning. Decisions that let build-up in the flood hazard areas will be only issued for each specified undertaking. The process of issuing decisions exempting from bans related to the usage of flood levees has also been regulated.

The second stage of Flood Directive implementation, involving the elaboration of Preliminary Flood Risk Assessment (PFRA), was completed by the Polish government at the end of 2011, at the same time meeting the deadline. The preliminary assessment aimed at estimating the scale of flood hazard for the river basin areas and identifying the significant flood risk (PFRA 2011). According to the novelized Water Law[6] (abb. WL) (WL, Art. 88b), Preliminary Flood Risk Assessment should include, inter alia, assessment of potential negative effects of floods which may occur in the future, for human life and health, the environment, cultural heritage and economic activity, including: topography of the area, localization of watercourses and their general hydrological and geomorphological characteristics, including floodplains as natural retention areas, the effectiveness of existing flood and regulating structures, localization of residential areas and localization of areas with economic activity, and if possible long-term event forecast, and in particular the influence of climate changes on the occurrence of flood, and in particular defined areas of flood hazard.

[6] Act of 18 July 2001 on Water Law (consolidated text: Journal of Laws [Dz.U.] 2012 item. 145, 951 as amended).

The elaboration of Preliminary Flood Risk Assessment is within the competence of the Head of National Water Management Board (HNWMB), ant it should be updated every 6 years (WL, Art. 88c). The introductory flood risk assessment was carried out in Poland in accordance with the *Methodology of introductory flood risk assessment* elaborated by the National Water Management Board (NWMB 2010).

As a result of Preliminary Flood Risk Assessment (PFRA) in Poland, areas of flood hazard were defined which, according to the Directive, during the next stages of flood risk assessment, will be subjected to detailed hydrological and geomorphological analyses. Areas of flood hazard are the areas where there is a significant flood risk or where the occurrence of flood risk is probable. Significant flood risk was identified based on the range of historical floods, i.e. floods which had great negative impact on human life and health, the environment, cultural heritage and economic activity, including the assessment of these effects, flood range and routes of flood and other floods which occurred in the past, and in case of which there is a probability that similar flood events will have negative effect on human life and health, the environment, cultural heritage and economic activity, and probable significant risk – based on the flood water range with a defined probability of occurrence indicated in flood protection studies.

In order to define the areas exposed to flood hazard, the initial area for analysis was determined, so called potential flood hazard area, based on the criteria in the following hierarchical order:

1. flood protection studies,
2. historical floods,
3. geomorphological analyses,
4. analyses of the influence of water devices on flood safety and
5. long-term forecasts, including the influence of climate on flood occurrence (Fig. 1).

According to the methodology elaborated by the National Water Management Board, geomorphological analyses should be conducted based on numerical land models (NMT) presenting the shaping of river valley surfaces (Zwoliński 1992). It should be underlined that in the case of many rivers in Poland, the NMT had not been elabo-

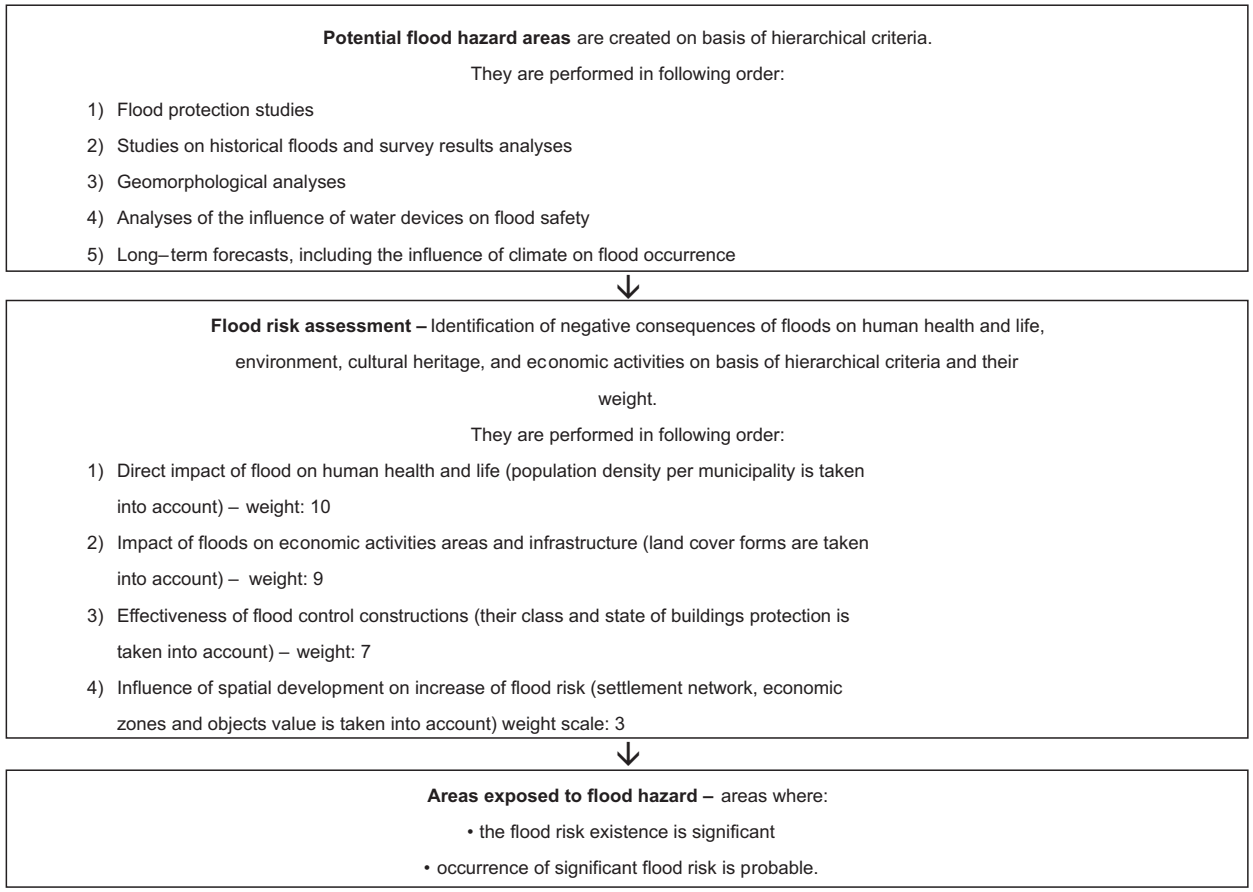

Fig. 1. Phases of Preliminary Flood Risk Assessment in Poland based on Preliminary Flood Risk Assessment

rated, which largely hampered the determination of borders of potential flood hazard, and consequently the borders of areas exposed to flood hazard. Due to the lack of data, the criterion of climate influence on flood occurrence was not taken into consideration[7] (PFRA 2011).

The introductory flood risk assessment in the areas of potential flood hazard involved determining the negative consequences of flood for human life and health, the environment, cultural heritage and economic activity. According to the methodology of the National Water Management Board, the risk should be determined based on four hierarchical criteria, using weighted point method, i.e. determining the number of points for given floodplains, considering the importance of particular criteria also given in points (PFRA 2011). The flood risk level in a given riverside area is also defined by the sum of all points determined based on particular flood risk assessment criteria for flood risk assessment considering their importance. The level of flood risk is directly proportional to the number of obtained points, which means that the higher number of points corresponds with the higher risk in the analysed area[8].

The first and most important criterion of flood risk assessment was definting the direct influence of flood on human health and life, using the unit of population density of whole municipalities based on the data from the Central Statistical Office. The influence of flood on the areas of business activity and infrastructure was then defined by determining within the flood range the resi-

[7] The assessment of climate influence on the occurrence of flood in the PFRA was only applied for sea costal areas.

[8] In order to determine areas exposed to flood hazard, all the analysed areas have been descendingly arranged, according to the number of points, and the river lengths classified were those which exceeded the treshold value (the highest hydrographically located cross-section in relation to its estuary) determined by the PFRA in consultation with HNWMB. Only the rivers with the catchment areas <10 km^2 were analysed (PFRA 2011).

dential and industrial areas, as well as transport infrastructure, agricultural areas and forests, in accordance with the CORINE Land Cover 2006 base at level 3, and for roads and railways – in accordance with the data of the Centre for Geodetic and Cartographic Documentation. The highest level of flood risk – the highest number of points, according to the Methodology of National Water Management Board (NWMB 2010) is characteristic for residential and industrial areas, while the lowest level – for forest areas (Table 3).

Another assessed element was the effectiveness of existing flood structures, their category and protection level. When considering this criterion, in many cases the exception was made from the Methodology of National Water Management Board (NWMB 2010), due to the undetermined flood levee classes, as well as areas protected by the levee and areas of hazard due to the potential damming structures failure. The most important, from the point of view of the problem raised in the article, the criterion of flood risk assessment, involving the determination of how the spatial development influences the increase in flood risk, was not included in in the Preliminary Flood Risk Assessment as the data needed for the analysis were incoherent and of various quality.

The assessment of the influence involved determining the pressure on the development of areas exposed to flood hazard and the value of objects included in the spatial development plans located in these areas (PFRA 2011). As a result, based on the above mentioned three partly modified criteria of flood risk assessment, the areas threatened by flood hazard were determined in two planning cycles[9].

The Preliminary Flood Risk Assessment demonstrated the lack of spatial data, also in the digital form, and in particular the numerical model of the area, flood levee categories, surface area of land protected by levee and areas of hazard in case of damming structure failure, as well as data concerning the development of settlement network, economic zones and transport systems.

Table 3. Methods of assigning points considering the form of land cover in CORINE Land Cover database (PFRA 2011)

Classification of land cover forms	Points defining risk level
Residential areas	5
Industrial areas	4
Communication infrastructure	3
Agriculture	2
Forests	1
Other	0

Preparatory works for the implementation of subsequent stages of Flood Directive in Poland

The subsequent three stages of Flood Directive implementation in Poland, involving the elaboration of flood hazard and flood risk maps and plans of flood risk management have been completed.

By the end of 2013, Poland is obliged to elaborate maps of flood hazard for the areas exposed to flood risk, determined in the Preliminary Flood Risk Assessment. The maps of flood hazard will include detailed classification of floodplains considering the hazard level (compare Tedim, Carvalho 2010). In accordance with the novelized Water Law, areas of low flood hazard are characterised by the range of flood occurring once in 500 years, areas of medium hazard – by flood occurring once in 100 years and areas of high hazard – once in 10 years. The latter two groups of floodplains, of medium and high flood hazard, are the areas of special flood hazard.

The maps of flood hazard also distinguish areas exposed to flooding in case of water overflowing the levee top, destroying or damaging flood levees, destroying or damaging damming structures (Art. 88d). Additionally, within the flood zone flood water depth is determined as well as its speed and direction (Water Law, Art. 88d) (Fig. 2).

[9] Rivers, for which the maps of flood hazard and risk are to be elaborated have been divided into two groups, that is the ones intended for elaboration in the first turn – 1st planning stage, and in the second turn – 2nd planning stage. Finally, in the area of Poland 839 rivers with total length of 27,161 km were classified in the areas exposed to the hazard of flood, including 253 rivers with total length of 14,481 km in the 1st cycle, and 586 rivers with total length of 12,680 km in the 2nd planning cycle. In turn, 548 rivers were not classified in the elaboration of flood hazard and risk maps (Introductory Assessment of Flood Risk PFRA 2011).

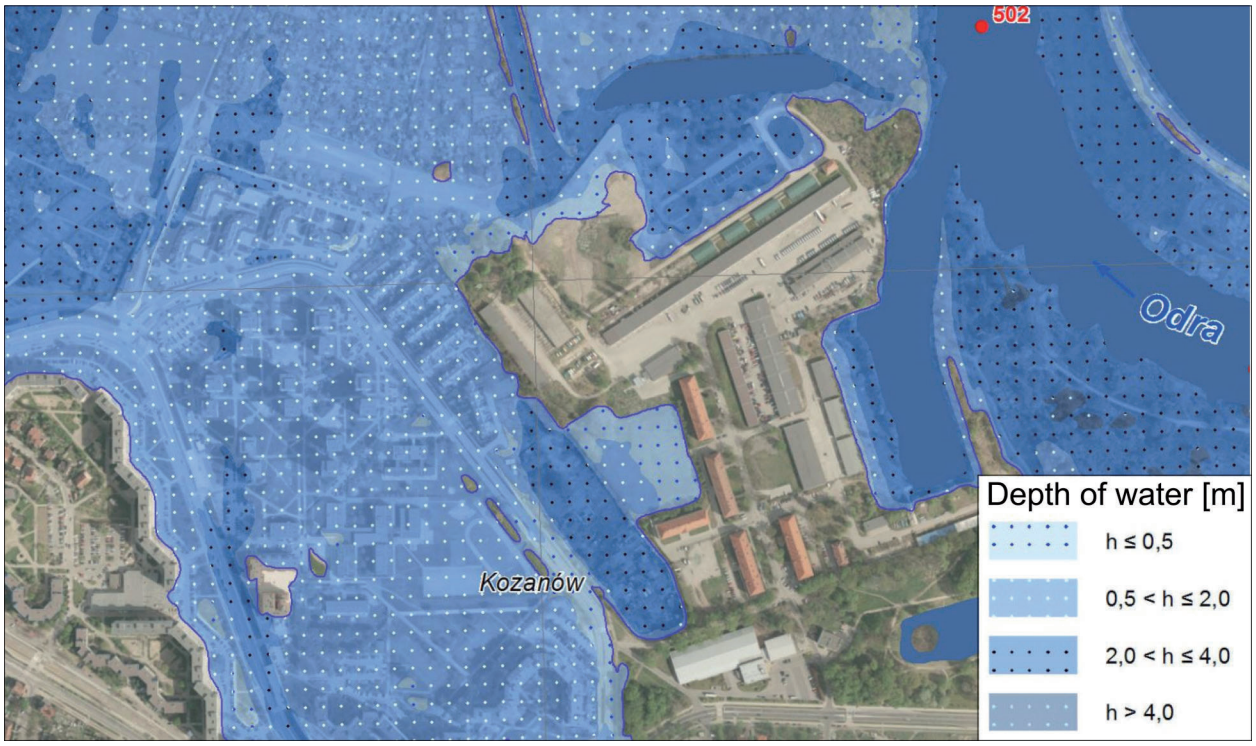

Fig. 2. Sample flood hazard map (with depth of water) (isok.imgw.pl, accessed 5 March 2014)

In order to determine the method of drawing the maps of flood hazard and risk, the Polish government passed a regulation in addition to the Water Law on 21 December 2012[10], according to which the flood range on the maps of flood hazard will be marked using the digital elevation model, and the speed and direction of flood water flow – based on the numerical model of land cover (§5). In order to elaborate these models, the LiDAR aerial laser scanning has been performed since 2011 along the watercourses in the area of Poland. Air-borne pictures in two standards of different fidelity[11] have also been taken (Fig. 3). As a result of LiDAR laser scanning, a cloud of points has been obtained to which a digital elevation model of area and numerical model of land cover can be introduced and the height of land covered can be determined. These models will allow for the determination of flood water speed and direction. Another stage of implementing the Flood Directive in Poland will be the elaboration of flood risk maps for the areas of special flood hazard, previously marked on the flood hazard maps (Fig. 4). The method of elaborating flood risk maps in Poland will be based on the method used in Germany (*Rozporządzenie… 2012*). Flood risk maps will consist of maps in two thematic sets: (1) map of hazard to people and potential flood-generated loss, (2) map of use of land, areas and structures of particular cultural, natural and economic importance (§8).

The first one will show, along with the potential flood-generated loss, the estimated number of inhabitants exposed to flood hazard, residential buildings and buildings of particular importance for the society (e.g. hospitals, schools) exposed to flooding to the height of: below 2 m and above 2 m (§9). The other map will define such classes of land use as: residential areas, industrial and communication areas, recreational and holiday areas, as well as agricultural land and other water classes. The map will also include forms of nature protection occurring within the flooding borders, areas of special cultural importance (e.g.

[10] Regulation of the Minister of the Environment, Minister of Transport, Construction and Maritime Economy, Minister of Administration and Digitization and Minister of the Interior of 21 December 2011 on the elaboration of flood hazard maps and flood risk maps (Journal of Laws [Dz.U.] 2013 item 104).

[11] Standard I for open and hardened surfaces: net with 1 m interval, height accuracy at least 0.15 m, Standard II for forest areas: net with 1m interval, height accuracy at least 0.30 m.

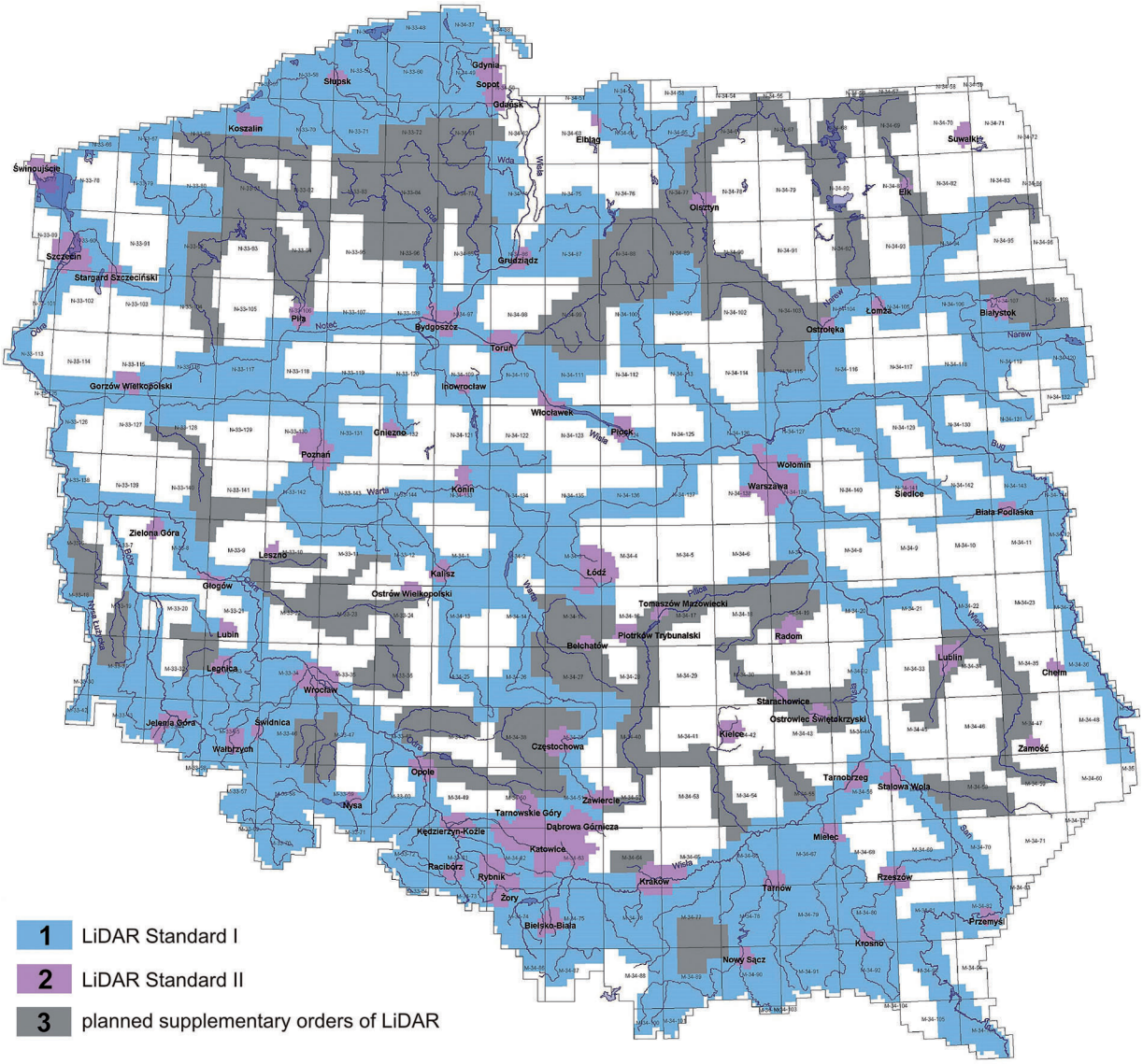

Fig. 3. Range of laser scanning and satellite pictures in Poland (www.gugik.gov.pl, accessed 12 March 2012)

palaces, museums) and industrial plants and other potential sources of water pollution (e.g. sewage treatment plants, landfills) (§9).

In order to determine the potential loss, the regulation determines the property value for six out of eight distinguished classes of land use (residential areas, industrial areas, communication areas, forests, green and sports areas, agricultural land), and additionally, for residential, industrial and communication areas – the degree of property loss which depends on the depth of flooding (§11).

The highest property values were established for residential, industrial and communication areas. The property values for a given land use class were determined based on the property values given in Germany[12], with consideration to the differences between the Polish and German economy. The potential loss is therefore affected by the way of floodplain development, depth and extent of flooding. Spatial distribution of potential flood-generated losses within the flooding area will be presented on a map belonging to the first thematic set of flood risk maps.

The final stage of Flood Directive implementation in Poland will be elaborating plans for flood risk management for river basins and water regions. These include final documents, compris-

[12] Accurate way to determine the value of the property is presented in the justification for the Regulation on the elaboration of flood hazard maps and flood risk maps.

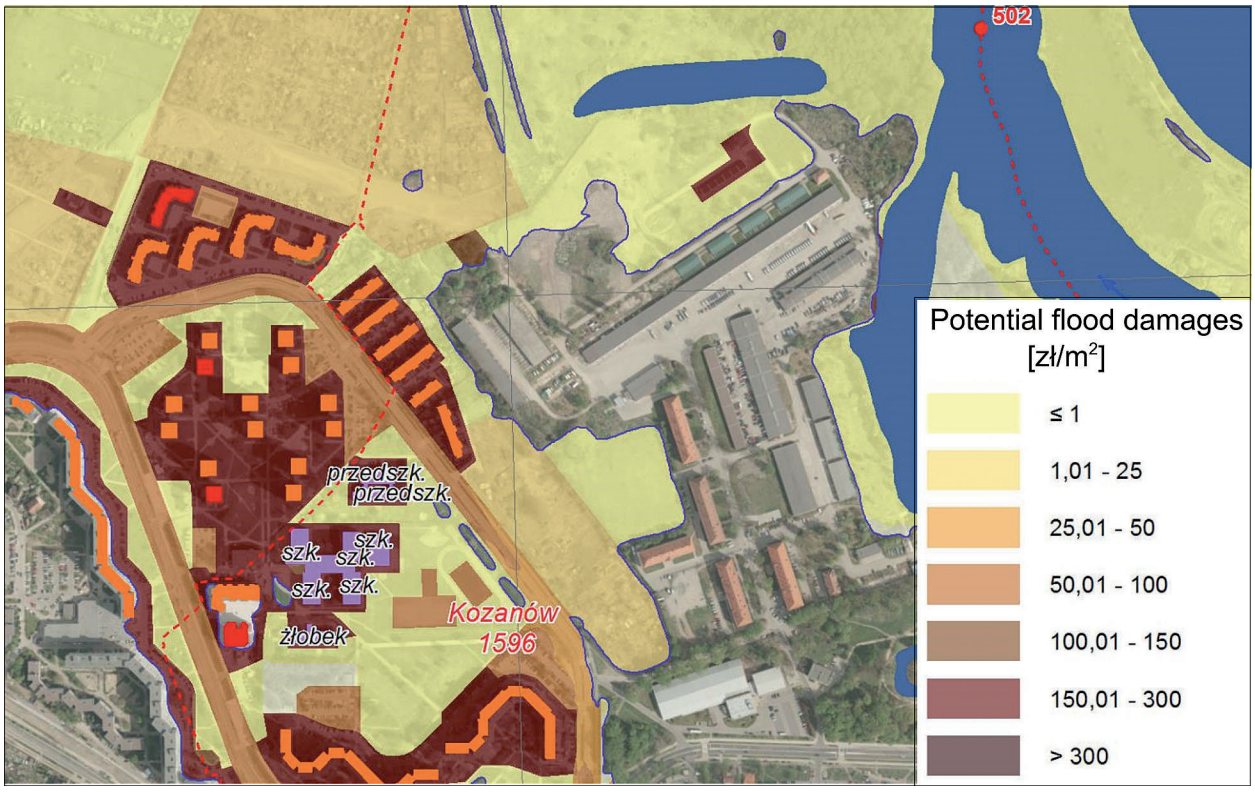

Fig. 4. Flood risk map – land use and protected areas, structures of potential risk for the environment (isok.imgw.pl, accessed 5 March 2014)

ing all the previous implementation stages, that is including the Preliminary Flood Risk Assessment and maps of flood hazard and risk. In accordance with the Water Law, the plan of flood risk management will include activities focusing on preventing, protecting and forecasting floods, as well as the early warning systems.

The aims of flood risk management defined in the plan will focus on limiting the potential negative consequences of flood using non-technical means of flood protection. The plans of flood risk management will also present the analysis of costs and benefits, the areas of potential retention properties, and also the rules for managing water and land, elements of spatial planning and land development, as well as nature protection (Water Law, Art. 88g). The important fact is that during the elaboration of plans of flood risk management, their drafts should be announced in public, as the element of social participation in the process of drawing up a document, especially within the scope of defining and achieving aims of risk management that is limiting potential negative effects of flood on human life and health. The society has then the possibility to submit comments to the draft of the project (Water Law, Art. 88h). The society participation in the process of flood risk management is then ensured.

The preparation of all documents required by the European Union in relation to the implementation of Flood Directive, that is flood risk and hazard maps and plans for flood risk management for river basin areas is within the competence of the Head of National Water Management Board, while the directors of regional water management boards are only responsible for the preparation of risk management plans for water regions. In accordance with the novelized Water Law, the updating of all the above mentioned flood studies will be a six-year process.

The process of implementing the Flood Directive in Poland is carried out within the following project: Information System of Protection from extraordinary hazards (ISP). It is a project co-funded by the European Union within the Innovative Economy programme, which comprises not only protection from flood, but also from other natural hazards, including meteorological phenomena (droughts, strong winds). In the scope of flood protection, ISP's tasks involve collecting

initial data for the analyses and hydrological modelling, performing those analyses and elaborating the required maps of flood risk and hazard and plans of flood risk management. These studies will be made available for the society on the Internet portal.

Evaluation and significance of Flood Directive in Poland

The significance of Flood Directive implementation in Poland was evaluated by indicating the positive and negative aspects of its realisation (Table 4).

The positive elements refer both to the idea of document itself and to the chances resulting from its implementation in Poland. On the other hand, the negative aspects to great extent refer to the weaknesses of the Directive implementation performed to date by the Polish government and threats related to them.

The Flood Directive assumes the sustainable development of floodplains by including their environmental, social and economic aspects in the flood protection programme. Economic significance of floodplains was expressed by defining the potential values of flood-generated losses, which depend on the form of land development and flood water level.

The Flood Directive, however, stresses the significance of floodplains in terms of their retention properties. Additionally, it allows identifying, within the flood range, the areas of unique natural values (forms of nature protection) and sources of potential pollution. The social aspect of the directive involves the potential participa-

Table 4. Evaluation of the significance of Flood Directive implementation in Poland

Evaluation	
Positive	Negative
1. Sustainable development of floodplains by considering the economic aspect (flood-generated loss), social aspect (participation of society in defining aims of flood risk management) and environmental aspect (sources of water pollution, forms of nature protection, natural retention areas)	1. Lack of spatial data in digital form (land development, damming structures)
2. Extensive approach to the principles and directions of flood protection (risk management plan)	2. Exemption from the principles for the elaboration of Preliminary Flood Risk Assessment (PFRA) (influence of the development of floodplains on the increase in flood risk)
3. Strictly defined method of determining the range of flood areas – differentiating the range of flood hazard	3. Too general initial data in the Preliminary Flood Risk Assessment (population density of whole municipalities)
4. Possibility to impose bans on land development not only in the areas exposed to flood hazard	4. Outdated statistical data as a basis for determining the property value
5. Regulating the procedures of issuing decisions exempting from bans on developing inter-embankment zone and flood levees	5. Low social awareness of flood hazard and risk
6. Confidence in including floodplains and bans on their development in spatial development plans – strictly defined, legally binding deadline for elaborating obligatory flood hazard maps which have to be considered in area development plans	6. Strictly defined deadlines for the implementation of particular stages of the Directive (relatively short)
7. Digitalization and standarization of spatial data	7. High costs of Flood Directive implementation
8. Determination of floodplain borders based on the NMT	
9. Increase in the public availability of environmental information, related to flood hazard and risk	
10. Clear and uniform visualization of information on flood risk and hazard, understandable for everyone	
11. Well-developed systems of spatial information (methods of obtaining, collecting and processing spatial data)	
12. Development of studies in the field of hydrology, spatial planning, geomorphology, etc.	
13. Raising social awareness in terms of flood hazard and flood risk level	
14. Facilitating rescue actions during flood	
15. Standards concerning rules for insuring people and property in case of flood	
16. Improving flood protection level	
17. Regulating the process of investing in the area of floodplains – preventing flood-generated damage	
18. Improved safety of people and property	

tion of society in defining the aims of flood risk management and ways of achieving them.

Moreover, the plans of flood risk management will ensure extensive approach to the principles and directions of flood protection. They will allow for identification of areas of potential retention properties. Therefore, the Flood Directive promotes ecological way of flood protection, taking into consideration the environmental conditions, development of floodplains and water management in the river basin.

The novelized Water Law explicitly describes the way of determining particular types of floodplains. It gives a strictly defined probability figure for flood occurrence, indicating the range of flood water. At the same time, the legislators differentiate the hazard level in floodplains: low for the areas with flood occurrence probability once in 500 years, medium – once in 100 years and high – once in 10 years. This solves the problem of selecting one flood line, relevant for the land use plans, out of too many lines previously determined in studies of flood protection.

Moreover, the territorial range of introducing bans on land development and management in the areas at special flood hazard has been broadened, including a ban on land development, and other areas have been comprised, that is not only the areas beyond the line of flood levees (*former* areas at potential risk of flooding), but also ones for which flood risk level has not been defined.

The Directive implementation hindered the possibilities for the elevation of new building objects, including residential areas. Strict application rules for issuing the decisions on the exemption from the development ban in floodplains were specified, which do not allow for including such areas in the procedure of local land development planning. Procedures of issuing decisions exempting from bans related to the use of flood levees have also been regulated.

The deadline for elaborating maps of flood hazard and risk precisely defined in the law and obligation to have all these maps included in area development plans ensures their execution, because to date the elaboration of flood protection studies has been optional. Secondly it provides the implementation of restrictions and prohibitions to the land development of flood hazard areas. As a result HRWMB may control, if restrictions and prohibitions depicted in flood risk and flood hazard maps are respected in area development plans. Thitherto, local land management plans has not always included the range of flood hazard, which resulted in the land development situated directly along water courses.

Apart from the above, the implementation of Flood Directive in Poland imposes the obligation to digitalize geographical data to the vector form and it ensures their standardization. This allows for identifying the degree and form of development of floodplains, as well as elaborating numerical models of land cover, which in turn ensure the exact marking of flood water borders using a linear and two-dimensional hydrological modelling.

Another positive aspect of implementing the Flood Directive in Poland is the increase in the availability of information on the environment, and namely on the level of flood hazard and risk by placing the maps of flood hazard and risk on the Internet portal. Flood hazard and risk maps are also a clear and uniform way of visualizing information on the range and level of flood water, speed and direction of water flow, and the forms of floodplain development, the degree of potential flood-generated losses, as well as protected areas and sources of pollution located within the flood range. Such a clear form of conveying information on the level of flood hazard and risk will surely reach the majority of the society without any barriers.

The implementation of Flood Directive in Poland stimulates the development of systems of spatial information in Poland, including the methods for obtaining, collecting and processing spatial data. Completing the spatial data base in the digital form will prompt futher development of studies in the field of hydrology, spatial planning, geomorphology, etc. Public availability of maps of flood hazard and risk will allow for raising social awareness related to the degree of flood hazard and risk.

Elaborating the plan of managing flood risk will facilitate rescue actions during flood, and maps of flood hazard and risk will be supportive element for the introduction of standards concerning the rules for insuring people and property in the areas of flood hazard. Political and financial support from the European Union is also

a great chance to increase the flood protection level in Poland.

Finally, the implementation of Flood Directive in Poland will regulate the investment process in the areas of floodplains by hindering potential negative consequences of flood, including damage caused by the development of floodplains. In consequence, the Directive implementation in Poland will cause the increase in securing the safety of people and property from flood.

Along with a number of advantages related to Flood Directive implementation in Poland, some disadvantages can also be observed, which in the further stages may pose a threat to its completion. First and foremost, there are insufficient geographical data in the digital form, mainly related to information on the development of floodplains and damming structures, due to which the Preliminary Flood Risk Assessment in Poland is not complete. There have been exemptions from many objectives indicated in the methodology of elaborating the Preliminary Flood Risk Assessment (PFRA), including the exemption from defining the influence of floodplains development on the increase in flood risk. Secondly, in the Preliminary Flood Risk Assessment (PFRA) the initial data used are too generalized.

This concerns in particular the use of the unit of population density to determine the direct influence of flood on human life and health. In this case only the population density of the areas located in the direct vicinity of the investigated rivers should be taken into consideration, and not the population density of whole administrative units.

Apart from that, in order to determine the value of property exposed to flood risk in Poland, relatively outdated statistical data were used, presenting the state as of the year 2008. Another risk for the implementation of Flood Directive in Poland is the low social awareness of Polish citizens in terms of flood hazard and risk. Furthermore, strictly defined, and relatively short, deadlines for the implementation of particular stages and high costs also put the implementation of Flood Directive in Poland at risk.

Conclusions

To date, Poland has completed four first stages of Flood Directive implementation. The legal transposition and the Preliminary Flood Risk Assessment have been carried out. By the end of 2015 Poland is obliged, similarly to other EU member states, to complete the last stage, that is to elaborate plans of flood risk management. At present, above the area of Poland the following activities are carried out: aerial laser scanning and taking air-borne pictures in order to complete the data for further geomorphological analyses, which will allow for the determination of floodplains and flood risk areas.

The Flood Directive focuses on the process of developing floodplains, the value of endangered resources and underlines the environmental significance of floodplains as *natural retention areas*. The Directive implementation requires the completion of digital geographical data.

It should be expected that the implementation of Flood Directive in Poland will increase the safety of people and property by accurate and detailed determination of floodplains based on the numerical model of land, and the public availability of flood hazard and risk maps will raise the social awareness in terms of flood hazard and risk level. The implementation of Flood Directive in Poland is, therefore, of planning, environmental, economic, informative and social importance.

Acknowledgments

The author is a scholar within Sub-measure 8.2.2 Regional Innovation Strategies, Measure 8.2 Transfer of knowledge, Priority VIII Regional human resources for the economy Human Capital Operational Programme co-financed by European Social Fund and state budget.

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