

RETENTION CAPACITY ASSESSMENT FOR THE PILSEN REGION

TERRITORIAL STUDIES

ABBREVIATED REPORT

THE INSTITUTE FOR REGIONAL INFORMATION, Ltd.

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Introduction

LABEL: Transnational Cooperation in Risk Prevention

Project LABEL (1CE037P3) aims to improve the management of flood risk on the Elbe River and adjacent watersheds. The goal of the international project is to adapt human activities in the Elbe River catchment area to the threat of flooding and to reduce natural and man-made risks, along with their impacts. The project is being funded by the Operational Program Transnational Cooperation in Central Europe from the European Regional Development Fund, with implementation taking place from September 2008 to February 2012.

The project includes Czech, Hungarian and German partners, consisting of governmental administrative bodies, local authorities and professional institutions both from the Elbe region and nationwide. The project centers on cooperation between territorial planning and water management bodies in managing flood risks, developing strategies and taking measures to diminish flood risks. The chief project partner is the Saxon Ministry of the Interior. Czech partners in the project include the Ministry of the Environment of the CR, seven regions in the Elbe river basin (South Bohemia, Pilsen, Hradec Králové, Central Bohemia, Liberec and Pardubice), and the state owned enterprises Elbe Catchment Area and Vltava Catchment Area.

1. Project goals

The Pilsen Region, as a partner in the LABEL project, has had a territorial study prepared entitled Retention Capacity Assessment for the Pilsen Region. The study focuses on evaluating natural retention conditions, the retention capacity of existing and planned sites for surface water accumulation (proposed reservoir sites) and regional conflicts, along with potential floodplains and floodwater accumulation, and seeks to provide an overview of flood control measures implemented. The project's goal is to propose conditions and measures to improve floodwater accumulation conditions and reduce the risk of flooding, which will then be presented in international workshops targeting the transfer of information and experience.

The study will also serve as conceptual material for state administrative bodies, taking into account and respecting legal, economic and social concerns in territorial planning.

2. Description of the issue

In recent decades, the Pilsen Region has undergone fundamental alterations in municipal land use. Residences and industrial concerns have, in a number of cases, been located

in areas mistakenly thought to be safe from flooding. Runoff conditions in urbanized areas and the extent of damage to localities have fundamentally changed because of building in flood zones, regulation of rivers, the construction of reservoirs, dykes, surface reinforcement and the construction of a pronounced number of large buildings.

But flooding is essentially a natural phenomenon which cannot be completely eliminated; it may only be regulated to try to minimize damage to the greatest extent possible.

This is done primarily via biological, biotechnological and forestry measures which promote an increased capacity on the part of the land to retain quantities of rainwater and which build upon the natural environment's intrinsic functioning. The primary technological flood safeguards are man-made levees, reservoirs and polders (dry tanks). Their disadvantage consists in their high cost of acquisition and operation, the relatively large area of land they require and their substantial impact on the natural environment. A plus, by contrast, lies in their proven effectiveness, something which may be precisely quantified.

Another significant problem may consist in the gradual reduction of groundwater due to increased global warming and climate change which bring a potential for evaporating waterways. An equally important issue for future territorial planning relates to surface water accumulation as regards drinking water supplies for the population and ecological river flows.

3. Project region

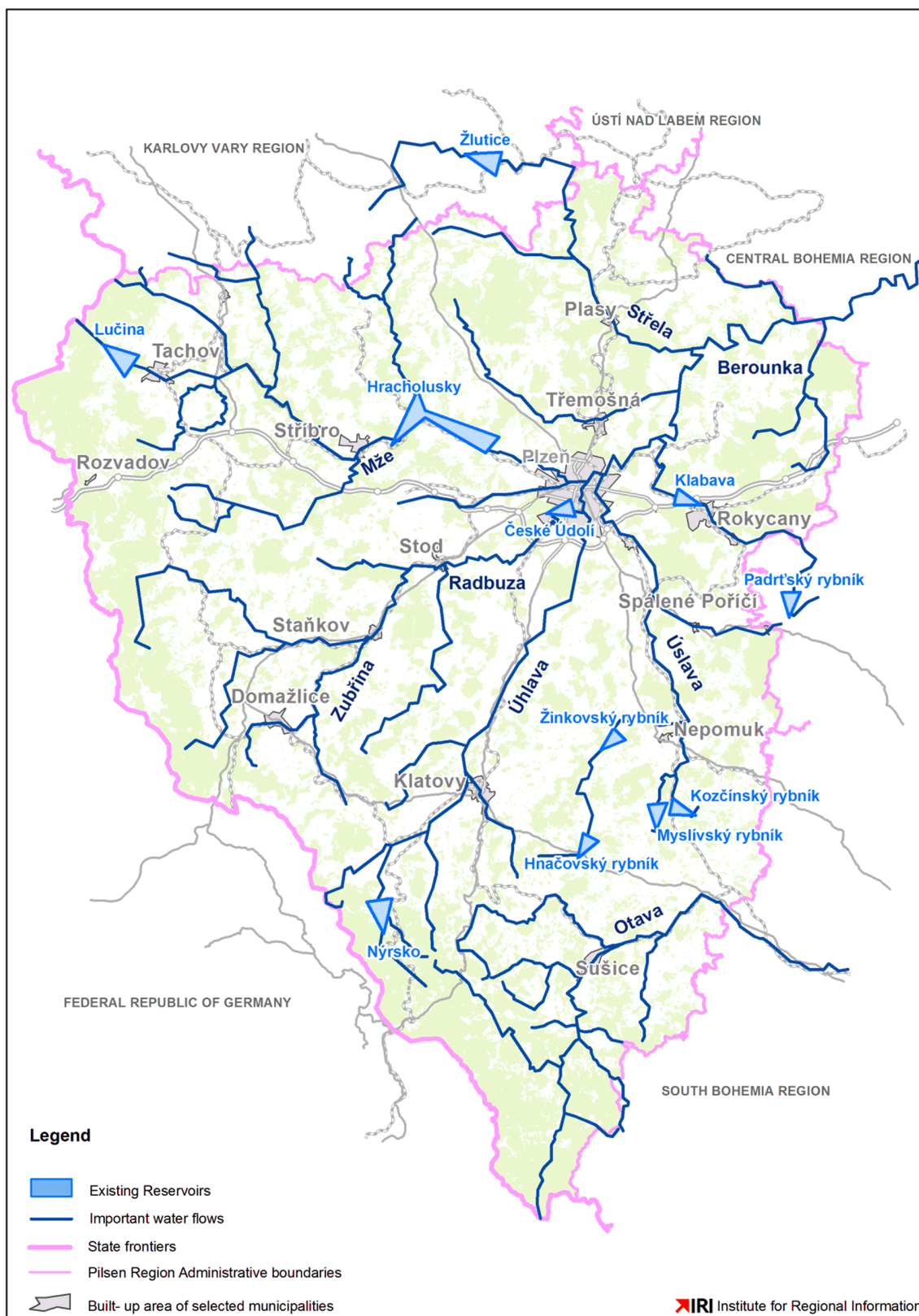
The Pilsen Region lies on the western border of the Czech Republic with the Federal Republic of Germany. It is the third largest region in the Czech Republic.

The Pilsen Region largely falls in the Berounka catchment area. Only that portion of the region which diverts water from the Otava River lies within the Upper Vltava basin. Geomorphological conditions have a major impact on the formation of river networks. Mountains and valleys in the border area near Pilsen contribute to the fanlike character of the river network. This convergence of flows in Pilsen therefore represents an increased flood risk for the region.

The main arteries in the upper portion of the Berounka catchment area are the Mže, Radbuza, Úhlava and Úslava. The main artery in the lower portion is the Berounka itself, which diverts water away from the Pilsen Region to the Central Bohemia Region.

The catchment area in the region is characterized by relatively low number of existing reservoirs but a large number of potential sites for new reservoirs. The largest reservoir is at Hracholusky on the Mže. Other reservoirs are at Nýrsko on the Úhlava, Lučina on the Mže, České Údolí on the Radbuza and Klabava on Klabava River. The region is also features large lakes (eg. Kozčínský, Hnačovský, Myslivský or Žinkovský).

Figure 1 Study area



4. Results obtained by the methodology

The goals of the study were determined using materials provided to the contractor by the Pilsen Region, the Vltava Catchment Area, the Czech Hydrometeorological Institute, the TGM Water Management Institute and other institutions. In evaluating flood risk, the Comprehensive Information System of Housing Economy (CISHE), operated by the Institute for Regional Information, was employed.

4.1. Evaluation of natural retention conditions

An evaluation of the natural retention conditions of the region was carried out by studying the impact of selected phenomena (criteria) on the region and carrying out mutual measurements and evaluations via grid analysis with the use of a hexagonal network, enabling flood origin locations to be located. Retention was evaluated on the basis of indicators for slope, average annual rainfall, the coefficient of ecological stability, soil type and forest coverage.

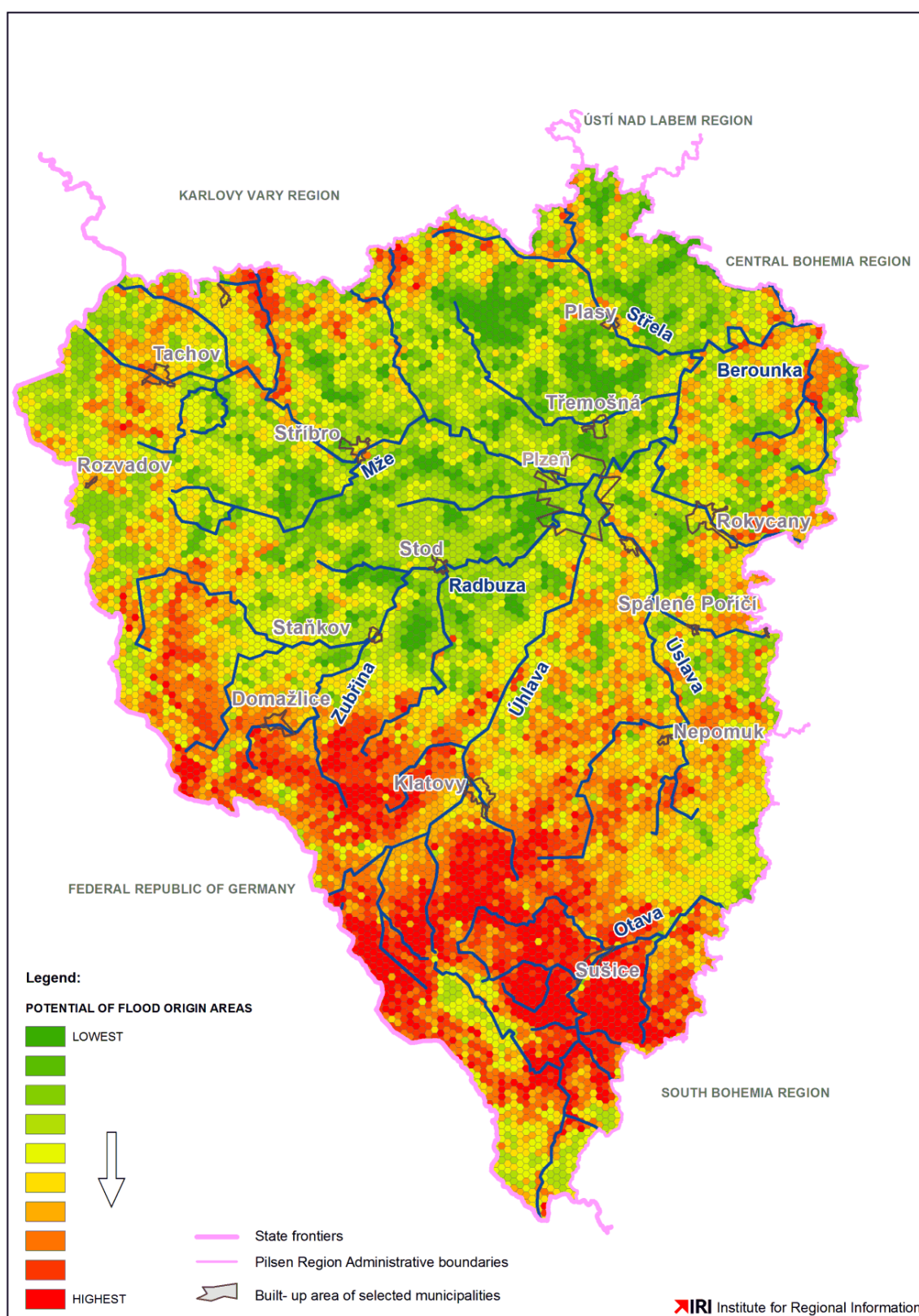
Flood locations (areas) were determined by using the weighted product sum of the point evaluations for specific indicators. The slope and average yearly precipitation have the most significant influence on the runoff of water from the area and are accorded a weight of 1. Lesser weight is given to soil type and forest coverage, with the least weight being given to the coefficient of ecological stability.

Conclusions:

Flood locations are primarily located in the mountainous areas of the southern portion of the region, in the Šumava and its foothills. The primary focus is the catchment area of the upper Otava, Úhlava and Radbuza, also partially impacted by the Czech Forest. Flood potential may also be found in the foothills of the Slavkov Forest (tributaries of the Mže) and Brdy (rivers Klabava and Bradava).

The results were used to evaluate the significance of proposed reservoirs in terms of their location on streams flowing below flood point locations. (Table 1)

Figure 2 Locations of Flood Points



4.2. Evaluation of the retention capacity of proposed reservoirs

All significant proposed reservoirs were inventoried and their retention capacities evaluated. Proposals for 51 reservoirs identified in the Territorial Planning Outline of the Pilsen Region (23 sites) and the Water Management Plan of Czechoslovakia from 1988 (28 sites) were studied. Expert appraisals were made of the retention area of the proposed reservoirs to transform the flood wave from Q100 to Q10.

A reduction in the level of flood risk reflected the positive impact of the proposed retention capacity of the reservoirs. Flood risk may be expressed in two variant forms:

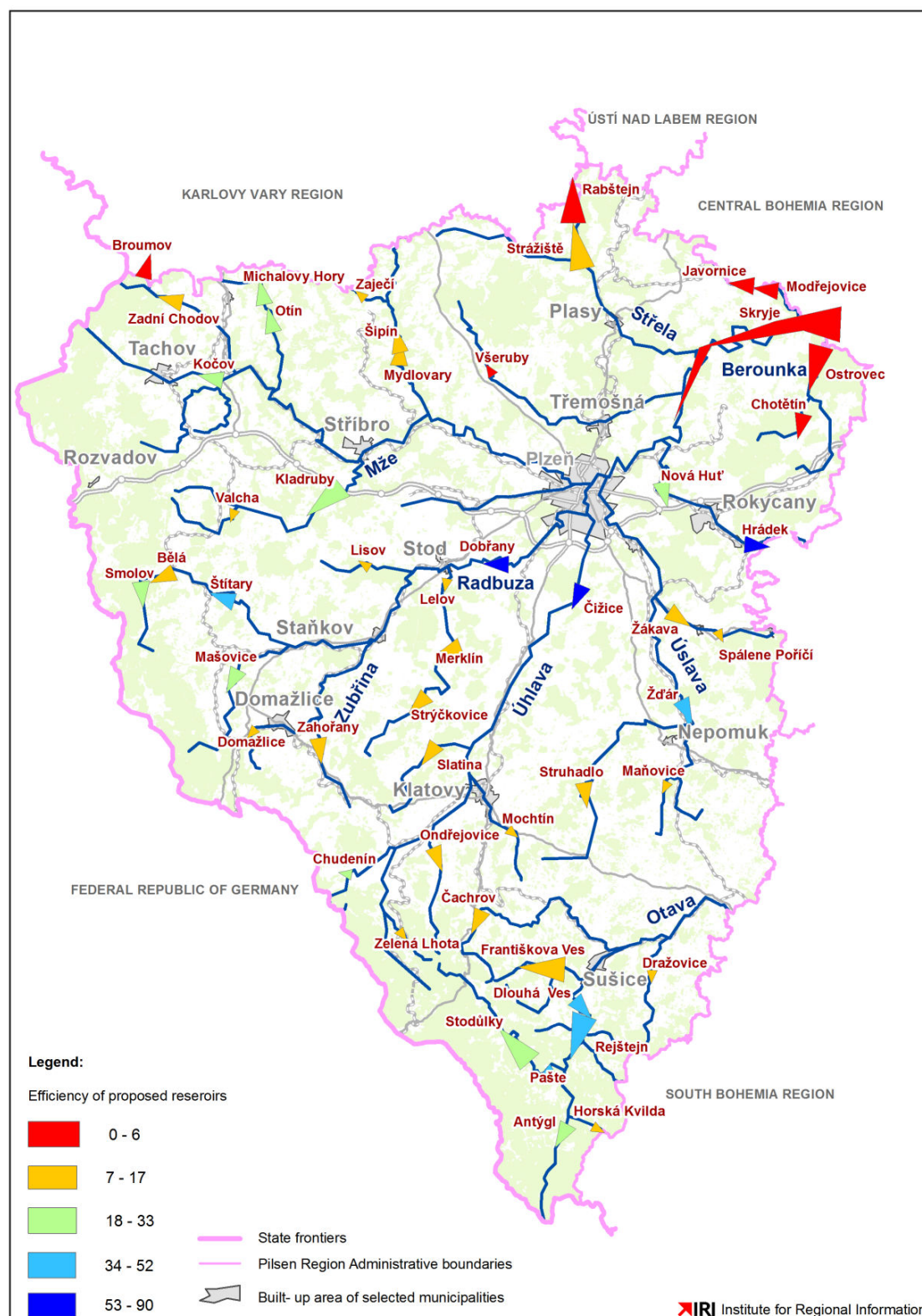
- a reduction in property values for properties located in Q100 flood zone, including parcel values,
- damage to property which is located in the Q100 flood zones.

The cost-effectiveness of constructing the reservoir was estimated using the costs for dam construction.

Conclusions:

Results of the retention capacity evaluation for the proposed reservoirs are given in Table No. 1. It was demonstrated that the following proposed reservoirs had a significant impact on flood protection: Hrádek on Klabava, Žďár on Úslava, Dlouhá Ves and Rejštejn on Otava, Štítary and Dobřany on Radbuza and Čížice on Úhlava. These reservoirs contributed significantly to protecting Pilsen (especially the Dobřany and Čížice reservoirs) and town Sušice.

**Figure 3 Overall Evaluation of the Positive Impact of Reservoir Retention Capacity
(with the view of flood risk reduction)**



4.3. Assessment of potential floodplains

An assessment of potential floodplains was carried out using spatial data analysis to locate points in flood zones rated Q100 which do not reach into the developed area and where there are no significant points or line objects, including proposed objects.

Land-use analysis documentation for the Pilsen Region was used as a basis, as well as land-use analysis documentation for the administrative region. A buffer zone of 10 to 50 m was set up around the developed area and around individual buildings.

All parcels discovered greater than 50 ha were identified as potential floodplains.

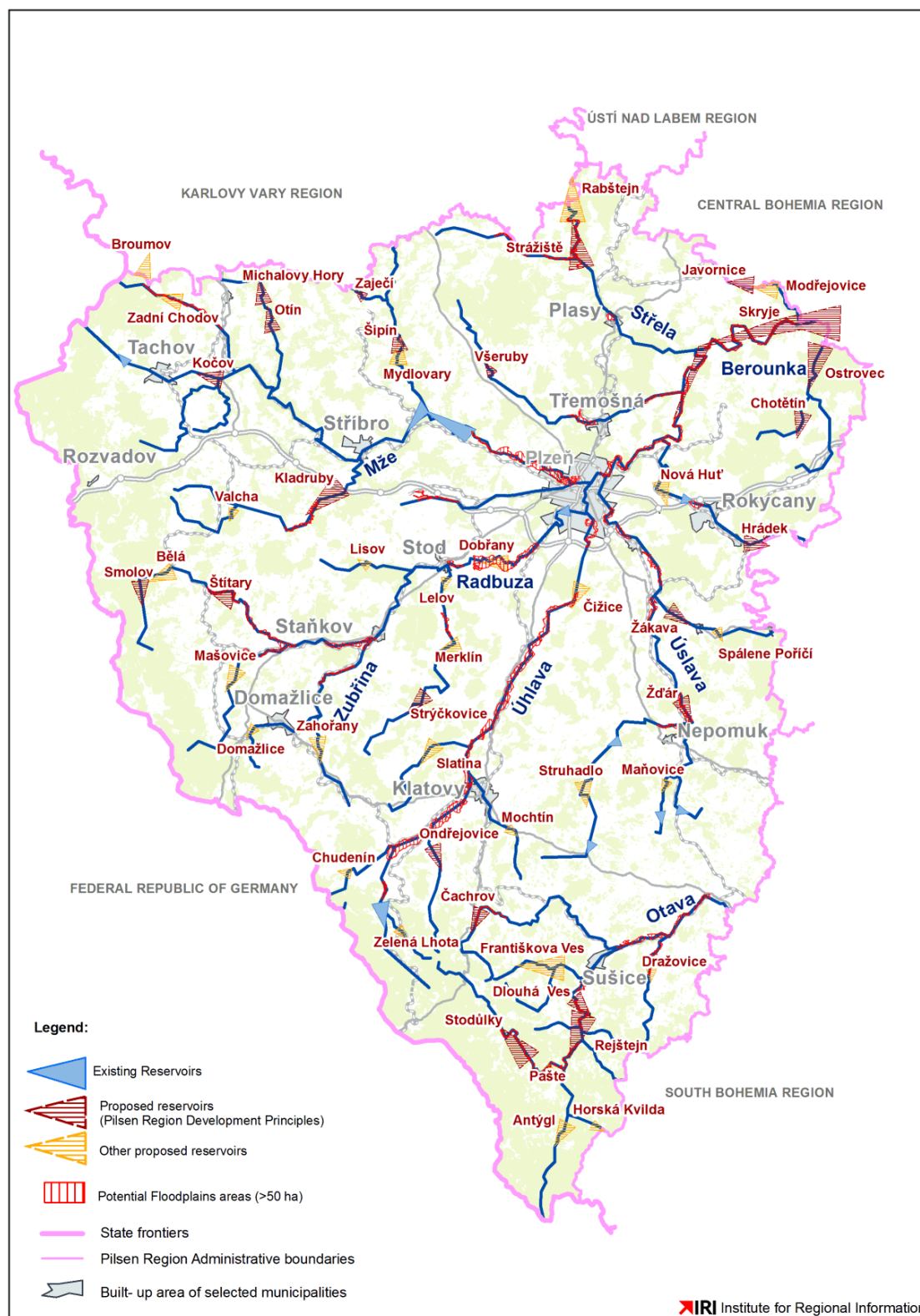
Conclusions:

52 potential floodplains with a total area of 8522 ha were identified in the Pilsen Region. Floodplains on the following streams are the greatest in area:

- Berounka - 5 areas, totaling 934 ha,
- Černý Potok – 2 areas, totaling 163 ha,
- Klabava – 2 areas, totaling 137 ha,
- Mže – 1 area, totaling 790 ha,
- Otava – 6 areas, totaling 706 ha,
- Radbuza – 7 areas, totaling 1466 ha,
- Střela – 2 areas, totaling 174 ha,
- Třemošná – 1 area, totaling 214 ha,
- Úhlava – 12 areas, totaling 2490 ha,
- Úslava – 6 areas, totaling 552 ha.

The most significant in terms of flood protection for Pilsen are the floodplains on the Radbuza, Úhlava and Úslava. On the Mže side, Pilsen is protected to a certain extent by the Hracholusky Reservoir. Otava floodplains are particularly important for the City of Sušice and the protection of Southern Bohemia.

Figure 4 Identification of floodplains



4.4. Evaluation of conflicts at proposed reservoir locations

An evaluation of area conflicts was carried out using a superposition methodology for all proposed reservoirs focused on the following:

- conservation of nature (sites of European importance, bird areas, particularly natural reservations),
- landscape preservation (landscape types, singularities, supervisual units),
- protection of settlements (settlement structures, historical and cultural monuments),
- transport and technical infrastructure,
- protection of land resources.

An evaluation system was prepared designating the extent of the threat presented by implementation of the proposed reservoirs. Results of the evaluation are summarized in Table No. 1.

Conclusions:

Localization was accompanied by a fairly high number of conflicts which require further detailed analysis for seven proposed reservoir sites delineated in the Territorial Planning Outline (Kočov, Ostrovec, Otín, Strýčkovice, Čachrov, Rejštejn and Skryje). Other sites appear problem free: Čižice, Chudenín, Lisov and Maňovice.

4.5. Summary of flood control measures implemented

A registry of flood control measures in this article which have been proposed and implemented was prepared:

- measures to shrink the retention area (dams, elevated flows),
- measures to increase the retention area (reservoirs, dry polders, floodplains).

Conclusions:

Questionnaires were sent to a total 501 municipalities in the Pilsen Region. Data on completed or proposed flood control measures were returned by 101 municipalities. 36 reported on flood control measures which had already been implemented and 74 responded that the municipality had not been affected by floods.

Dry polders were built at Bolešiny (on the Bolešinský stream - 2 dry polders) and at Zahořany (Zahořanský stream - 3 dry polders). An existing dam in Lochousice was replaced by a stone dam with overflow. In other municipalities, there were full capacity flows, construction of flood control embankments and reinforcement of the ecological and stabilizing functions of the land.

4.6. Surface water accumulation by individual catchment areas

The accumulation of surface waters was studied primarily because of the potential impact of climatic changes leading to the anticipation of more frequent drought periods.

Accumulation was studied for all proposed reservoirs contained in the Territorial Development Outline of the Pilsen Region, as well as for the aims of the water management plan.

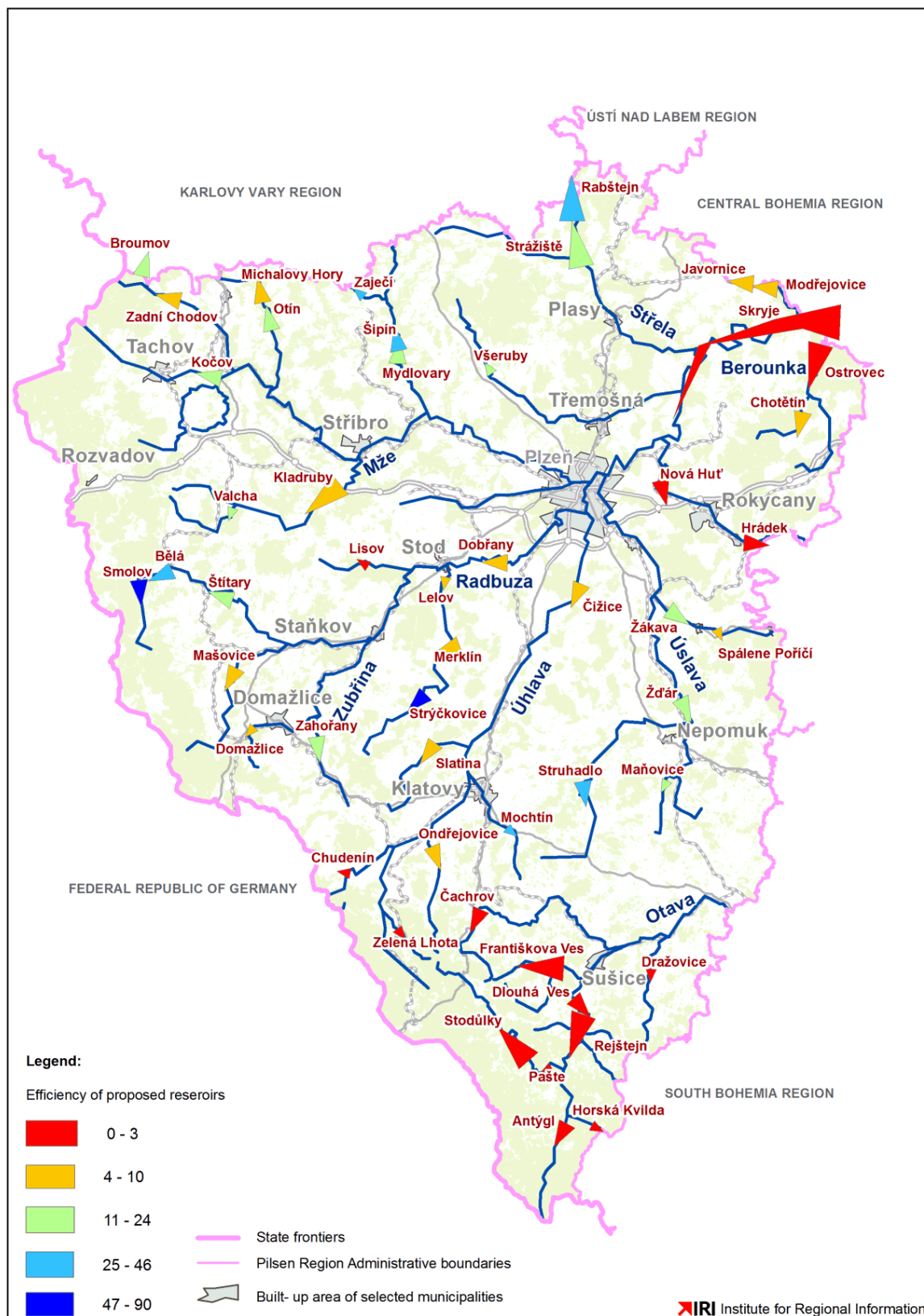
The degree of positive influence attributable to streams running below reservoirs in mitigating the impact of drought was used as an indicator for the influence of reservoir accumulation capacity on the threat of drought due to climatic change.

The cost-effectiveness of constructing the reservoir was estimated using the costs for dam construction.

Conclusions:

Results of the accumulation capacity evaluation for the proposed reservoirs are given in Table No. 1. Only four sites were found to have a significant impact on reducing the effects of drought. These are proposed reservoirs in Strýčkovice, Zaječí, Smolov and Bělá.

Figure 5 Overall evaluations as regards reducing drought impact



4.7. Areas categorized by potential for regulating flood drainage

Categorization was done using the results of the analyses described in previous sections. The following phenomena were given special attention:

- flood point locations,
- areas with proposed reservoirs beneficial for:
 - flood control,
 - reduction of drought,
- stream sections with extensive floodplains.

Conclusions:

Four categories were proposed:

- I. Areas lying alongside the lower section of a river, where there is a large quantity of water and neither polders nor reservoirs may be used for retention. The chief goal of flood control is local protection of settlements in developed areas, primarily by protective dams and measures to improve drainage conditions.
- II. Areas lying alongside the middle sections of the river, where there is a large quantity of water and neither polders nor reservoirs may be used for retention. The chief goal of flood control is local protection of settlements in developed areas by protective dams. At the same time, however, it is necessary to seek a managed approach to spillover waters, resulting in the least possible damage to property and transport and technical infrastructure.
- III. Areas lying alongside the middle sections of the river, where the quantity of water is such that, particularly in developed areas, dry polders and reservoirs may potentially be located. The chief goal of flood control measures is the reduction and delay of peak flood flows. Support must also be provided for the retention capacity of these areas by designing extensive green areas and ecologically stable systems.
- IV. Areas lying alongside the upper section of the river. The chief goal here is to increase the retention capacity of the area, primarily by designing extensive green areas, putting in dry polders, small reservoirs, revitalizing water flows, etc.

5. Designing conditions and measures to improve surface water accumulation and the reduction of flood risk

Conditions and measures to improve surface water accumulation and reduce flood risk have been proposed, taking into account the overall scope of the study, particularly as a basis for territorial planning and the territorial planning outline, as well as for individual municipality plans.

The measures include a proposed re-evaluation of the impact of proposed reservoir locations on the territorial planning outline for the region. Results of the evaluation were placed in an overview table annexed to this document. Each reservoir was assigned plus and minus points depending upon its significance for the following items, based upon the evaluation given in prior sections:

- Limits (extent to which the reservoir conflicts with territorial development limits).
- Floods (flood risk reduction rate),
- Drought (extent to which the effects of drought are minimized),
- Water supply (supplies of drinking water),
- Presence on a stream (stream localization where there is no significant existing reservoir),
- Flood generation (locating on a stream below a flood point),
- Climate change (location above an area where the model anticipates a more pronounced threat of drought).

The evaluation was used to select locations for reservoirs which:

- could be excluded from the proposal when the territorial development outline is updated or which may be put in a category of lesser importance (orange),
- would be beneficial to include in proposals when the territorial planning outline is updated (green).

The Ministry of Agriculture of the Czech Republic is preparing the General Plan for Surface Water Accumulation Areas, which is considered to be an adaptation measure to climate change in water management. The suitable Areas for accumulating drinking water and accumulating water for flood protection and for improving flow rates in the Pilsen Region are marked **red bold** in the Table No. 1.

After clarification, the floodplain delineated may also be included among territorial reserves for managed inundation during updating of the territorial development outline.

Categorization of areas serves as material for municipal planning. In addition to an emphasis on thorough protection of flood zones by limiting new building, the territorial plans of affected municipalities must include:

- the delineation of protected dams and diversion channels (relief branches), as well as protected developed areas (Category I),
- delineation of managed inundation areas, the inclusion of territorial reserves for proposed reservoirs which are significant in terms of flood control (Category II),
- delineation of managed inundation areas, the inclusion of territorial reserves for proposed reservoirs which are significant in terms of flood control, with an emphasis on increasing regional retention capacity (Category II),
- the inclusion of territorial reserves for proposed reservoirs significant to the water supply in mitigating the impact of climate change, with an emphasis on increasing regional retention capacity, forest coverage, small reservoir management, etc. (Category IV).

5.1. Project benefits for improving the flood situation in the Elbe catchment area

Benefits and measures may be roughly divided into the following categories:

- evaluation of flood risk reduction options in a significant portion of the Elbe catchment area,
- evaluation of water accumulation potential as regards mitigating the impact of climate change in a significant portion of the Elbe catchment area,
- proposed requirements for municipal territorial plans applicable in other portions of the Elbe catchment area,
- the potential for use of the proposed methods for mass evaluation of flood risks and water accumulation potential as regards the effectiveness of reservoir construction,
- the potential to use the proposed methods to define flood points and floodplains.

Procedures used to evaluate reservoirs used in this study may be applicable in other regions as well, both within the CR and across Europe in floods involving other catchment areas.

6. Annex – Evaluation of Proposed Reservoir Sites

Table No. 1: Evaluation of Proposed Reservoir Sites

Orange – Proposed reservoir which may be excluded from the category in question or transferred into a category indicating lesser significance

Green – Proposed reservoir appropriate for inclusion in territorial reserves.

Proposed Reservoir in the Pilsen Region Development Principles

Name	Stream	Limits	Floods	Drought	Water supply	Presence on a stream	Flood generation	Climate change
Hrádek	Klabava	++	++	--	+	+	+	+
Chotětín	Koželužka	+	--	-	o	-	o	-
Javornice	Javornice	++	--	-		-	-	-
Kladruby	Úhlava	-	o	-	+	-	-	+
Kočov	Mže	--	o	o	o	-	o	+
Michalovy Hory	Kosovský potok	++	+	--	+	-	+	-
Ondřejovice	Jelenka	+	o	-	o	+	+	+
Ostrovec	Zbirožský potok	--	--	--	+	-	+	-
Otín	Kosovský potok	--	o	o	o	-	+	-
Strážáň	Střela	o	-	o	+	-	o	+
Strýčkovice	Merklínský potok	--	-	++	o	o	+	o
Šipín	Úterský potok	o	o	+	+	-	-	-
Všeruby	Třemošná	++	--	o	o	+	-	o
Zaječí	Nezdický potok	++	-	++	+	-	o	-
Čachrov	Ostružná	--	-	--	+	+	+	+
Dlouhá Ves	Otava	-	++	--	o	+	+	+
Rejštejn	Otava	--	++	--	+	+	+	+
Skryje	Berounka	--	--	--	o	-	-	-
Smolov	Radbuza	+	o	++	+	o	+	o
Stodůlky	Křemelná	-	+	--	+	+	o	+
Štítary	Radbuza	+	++	o	o	o	+	o
Žákava	Bradava	-	o	o	o	+	o	-
Žďár	Úslava	o	++	o	o	+	o	o

The other Proposed Reservoirs in the Pilsen Region

Name	Stream	Limits	Floods	Drought	Water supply	Presence on a stream	Flood generation	Climate change
Antýgl	Vydra	-	0	--	0	+	0	+
Broumov	Tichá	+	--	0	+	-	-	0
Modřejovice	Javornice	0	--	-	+	-	0	-
Zelená Lhota	Zelenský potok	-	0	--	0	+	+	+
Bělá	Radbuza	--	0	++	0	0	+	0
Čížice	Úhlava	++	++	-	0	+	0	+
Dobřany	Radbuza	0	++	--	0	-	-	0
Domažlice	Zubřina	--	0	-	0	0	+	0
Dražovice	Nezdický potok	++	-	--	0	0	+	+
Františkova Ves	Volšovka	-	0	--	0	+	+	+
Horská Kvilda	Hamerský potok	-	-	--	0	+	0	+
Chudenín	Chodská Úhlava	++	+	--	0	+	+	+
Lelov	Merklínský potok	0	0	-	0	-	-	0
Lisov	Hořina	++	-	--	0	-	-	0
Maňovice	Myslínský potok	++	-	0	0	+	+	0
Mašovice	Čechovka	0	0	-	0	0	0	0
Merklín	Merklínský potok	+	0	0	0	-	+	0
Mochtín	Mochtínský potok	+	0	+	0	+	+	+
Mydlovary	Úterský potok	0	0	+	0	-	-	-
Nová huť	Klabava	-	0	--	0	0	0	+
Paště	Křemelná	-	+	--	0	+	+	+
Rabštejn	Střela	+	-	+	0	-	0	+
Slatina	Poleňka	-	0	-	0	+	+	+
Spálené Poříčí	Bradava	0	0	-	0	+	0	-
Struhadlo	Úslava	0	0	+	0	+	+	0
Valcha	Čapkovský potok	0	0	0	0	-	0	+
Zadní Chodov	Hamerský potok	+	-	-	0	-	0	0
Záhořany	Záhořanský potok	--	0	0	0	0	+	0