
Assessing the potential of unstructured geo-data from existing River Management Plans (RMP`s) to support the implementation of the EU-WFD using web-map services (ArcIMS/WMS)

Andreas ZITEK, Ingrid KOHL, Christian MAIRAMHOF, Michaela POPPE & Susanne MUHAR

In: Strobl, J., Griesebner, G., Car, A., Eds., *Geospatial Crossroads@GI_forum: Proceedings of the First Geoinformatics Forum Salzburg, Geoinformatics Forum Salzburg (GI_Forum), July 03-06, 2007, Universität Salzburg, 182-193; ISBN: 978-3-87907-461-7.*

Summary

In 2000 the European Union launched the Water Framework Directive (WFD). This legislation represents the overriding framework for sustainable river management of surface water resources within Europe. Existing geo-data represent a valuable source for both the assessment of the existing human pressures and the development of restoration measures, which are the main requirements of the directive. The most detailed spatial data exist from River Management Plans (RMP`s) on a local scale but are usually not easily accessible. New technologies like web-map services offer the opportunity to make distributed data accessible to a broader community. In a pilot project the Department of Water Management, Federal State Government of Carinthia, Austria, hosted data from two existing RMP`s on a GIS-server. Within this paper the potential use of unstructured data from river management plans via web-map services (ArcIMS/WMS) for assisting the implementation of the EU-WFD is evaluated.

1 Introduction

Freshwater ecosystems have suffered the most intense intervention of all ecosystems over the past 100 years of human history (COWX & COLLARES-PEREIRA, 2002). E.g. many fish species are now extinct, rare or endangered; the need for conservation action is paramount and the conservation of fish diversity remains one of the most difficult challenges facing the EU in preserving our natural biological diversity (DELPEUCH, 2002).

A political and legal framework focusing on ecological targets represents a pre-requisite for a successful, integrated and ecological river management. In the year 2000 the European Union therefore launched a new water legislation, the Water Framework Directive (WFD, URL-1) (WFD, 2000). Within this framework, a programme of measures is developed targeting at the rehabilitation of degraded aquatic ecosystems across Europe. The main focus is the management of river basins, the natural geographic and hydrologic unit. One of the key objectives of the WFD is to achieve the "good ecological status" of running waters by 2015. The definition and assessment of the ecological status is done by a normative scheme which is based on biological quality criteria. Four organism groups (fish, macrozoobenthos, algae, macrophytes) are used as indicators to describe the ecological status. All of these four quality indicators have to indicate the "good ecological status" otherwise measures for restoration have to be implemented. Other central targets defined in the WFD are to avoid further deterioration of inland waters, the development of river basin management plans and the information and participation of the public.

Another important legal framework on an EU level targeting at the conservation and management of ecological resources (based on a network of so called NATURA2000 areas) are the Birds directive and the Habitats directive. The implementation of these directives is supported by a specific financial instrument - the LIFE-Nature fund (URL-2).

The WFD especially claims for an integration of these areas relevant for aquatic resources during the implementation process.

On a national scale the Austrian Water Act represents the legal framework of action where the requirements for the national implementation of the WFD had to be integrated until 2003 (BMLFUW, 2005b).

The implementation of the WFD is guided by guidance documents for a common implementation strategy (CIS) (URL-3) and follows a straight timeline (Fig. 1). Until October 2005, fourteen guidance documents have been prepared covering many aspects of implementation, such as how planning processes should be carried out, how GIS should be applied and how public participation should be implemented. Generally GIS can be seen as a key technology for the implementation of the WFD (EC, 2003) and especially ArcIMS technology is thought to offer a variety of opportunities to contribute to the implementation of the WFD (DIETRICH, 2006).

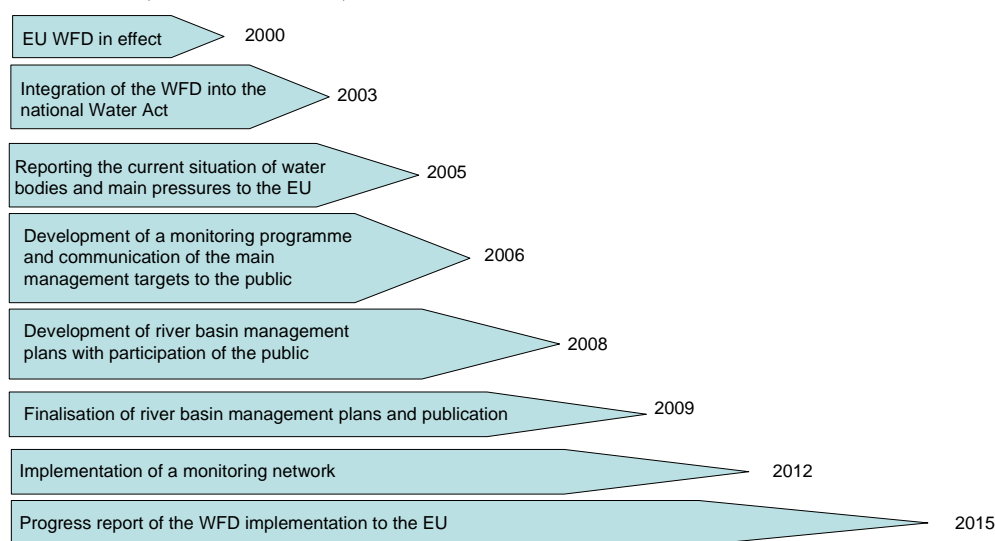


Fig. 1: Generalised time frame of the implementation of the EU-WFD.

The key instrument for implementing the WFD is the definition of integrated national river basin management plans. Specific programmes of measures have to be defined directed to the main human pressures occurring within each river basin.

Generally three spatial scales are of relevance for the implementation of the WFD: the river basin districts, the national planning areas and river type specific “surface water bodies”. Three main river basins are relevant for Austria: the Rhine, Elbe and the Danube catchment (BMLFUW, 2005a). Additionally these basins were further divided into eight national planning areas for the development of more specified management plans (Fig. 2, BMLFUW, 2005a).

For the strategic and national implementation of the EU-WFD the basic surface water bodies were further cut into the “detailed water bodies” (BMLFUW, 2005a). While the basic classification of the water bodies followed the geographical classification of natural landscapes (natural characteristics, bioregion...) the detailed classification of the water bodies was based the different combinations of pressures and the proposed ecological status. The basic water bodies are the relevant spatial scale for the monitoring of the ecological status, and the detailed water bodies characterised by typical combinations of pressures represent the starting point for restoration activities. The number of basic water bodies for rivers with > 100km² catchment area in Austria is 568 and 2596 for rivers with > 10km² catchment area. The number of detailed water bodies characterised by various combinations of pressures for rivers >100km² catchment area is 940 (mean length ~12km).

The management programs for the eight national river planning will be published by the Ministry of Life in 2009 representing the legally binding framework for the implementation at the Federal State level (BMLFUW, 2005b, Tab. 1). Furthermore any local water management action has to be in accordance with these management programs. Although

the WFD is generally based on the “polluter pays principle” it is still unclear how the management programs will be implemented and financially organised; probably a new funding scheme for ecological river management actions will be arranged by the new Austrian government (URL-4). Up to now only measures in the fields of water management in residential areas and protective hydraulic engineering are subsidized by the Ministry of Life on the basis of the Environmental Support Act (“Umweltförderungsgesetz”, ESA) and the Hydraulic Engineering Assistance Act (“Wasserbautenförderungsgesetz 1985”, HEAA). With these funds a great number of projects in the field of protective hydraulic engineering, taking also into consideration socio-political and ecological requirements, were implemented.



Fig. 2: Eight national planning areas in Austria: Rhein, Donau bis Jochenstein, Donau unterhalb Jochenstein, Elbe, March ,Leitha-Raab-Rabnitz, Mur, Drau (BMLFUW, 2005a).

Tab. 1: Instruments relevant for the implementation of the WFD at surface water bodies with main responsibilities and activities.

Implementation	Responsibility	Activity
WRRL	EU	Setting the legal framework and controlling the implementation of the WFD.
National river basin management plans	Government of Austria (Ministry of Life)	Development of a catalogue of measures for national planning areas, assessment of the ecological and economic efficiency of these measures; reporting the status of Austria's water bodies to the EU.
Regional implementation of river basin management plans	Federal State Governments	Implementation of the proposed types of measures within their national river basin districts, integrating the local spatial conditions with the aim to reach the good ecological status of water bodies, monitoring and reporting of the ecological status of water bodies to the Austrian Government.

One of the instruments targeting at the integration of hydraulic engineering for the protection against water-related hazards and ecological requirements on a Federal State level was the former (holistic) “River Management Plan” (“Gewässerbetreuungskonzept”,

RMP), now called “River Development Plan” (“Gewässerentwicklungskonzept”, RDP) (BMLFUW, 2006).

RMP`s were applied in Austria as a national planning instrument since 1989 (STALZER, 1994). A lot of detailed high quality data has been collected within these projects following a pre-defined scheme (1) a preliminary assessment of problems and existing data (2) an assessment of the current abiotic and biotic situation of the river system, (3) a definition of ecological and flood protection targets (visionary sectoral “Leitbild”-conditions), (4) development of a river type specific management plan, (5) definition of measures. Up to now more than 33 RMP`s have been implemented throughout Austria and GIS has been applied as a key technology for integrating spatial relevant data in RMP`s increasingly (MICHOR, 2003). Reports and data of the RMP`s were delivered to the local water management departments and were usually hardly available for other potential users. Because of lacking guidelines for data harmonisation a huge set of layers was collected for each RMP.

GIS generally represents a key technology within the implementation of the EU-WFD, but the current situation on spatial information in Europe and also on a national scale is one of fragmentation of datasets and sources, gaps in availability, lack of harmonisation between datasets at different geographical scales and duplication of information collection. Therefore on an European level the INSPIRE initiative (“Infrastructure for Spatial information in Europe”) aims at making available relevant, harmonised and quality geographic information for the purpose of formulation, implementation, monitoring and evaluation of Community policy making. With regard to the WFD on an European level the Water Information System Europe (WISE, URL-5) and on a national level the Water Information System Austria (WISA, URL-6) is being developed. In future all relevant data from different functional disciplines relevant to the WFD and also all relevant data from future RDP`s have to be integrated into a GIS with defined interfaces related to the WISA (BMLFUW, 2006). The lack of standardisation of topics and terminologies used within the existing RMP`s complicated the development of spatial data infrastructures (SDI`s) and a broad use of these high quality spatial data so far.

Especially for the timely implementation of the WFD all available data with regard to aquatic ecosystems represent a valuable source of information. Technologies like ArcIMS offer new possibilities of making distributed data accessible to a broader audience of stakeholders. Within the present paper, the potential use of unstructured data from two RMP`s via of web-map services (ArcIMS/WMS) to assist the implementation of the EU-WFD is evaluated exemplified by two case studies in Carinthia, Austria.

2 Study Area

Out of 8 RMP`s in Carinthia (Fig. 3), which spatially nearly equals the national planning area “Drau” (Fig. 2), two RMP`s (the RMP Glan and the RMP Gurk) were selected for the proposed tests. Large sections of both rivers are supposed to be at risk of not meeting the good ecological status required by the WFD (URL-6). In total RMP`s cover 554 km (41%) out of 1350 km riverine network with >100km² catchment area within the national planning area “Drau” (BMLFUW, 2005a).

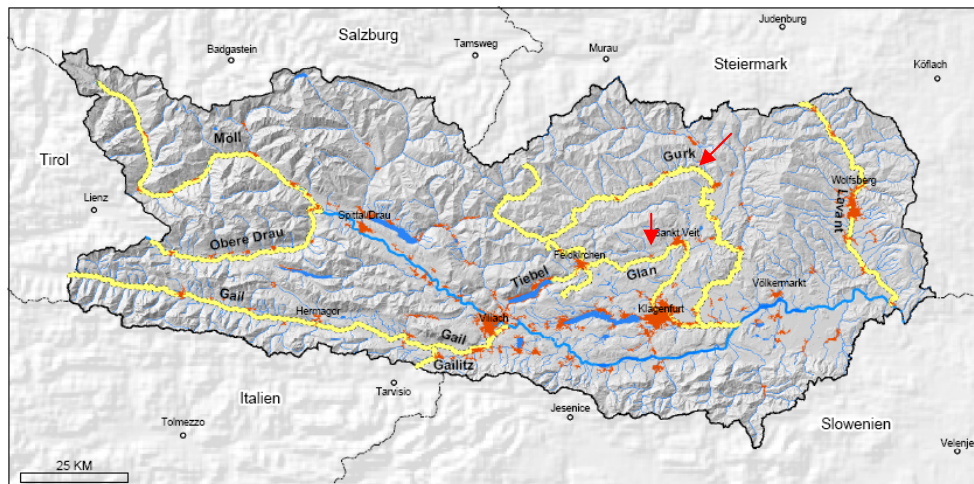


Fig. 3: Existing river management plans (RMP's) at the rivers Möll, Drau, Gail, Gailitz, Triebel, Glan, Gurk, Lavant (shown in bright lines) in Carinthia; the RMP's Glan and Gurk are marked with red arrows.

3 Data & methods

Data on land use, vegetation, flood risk areas, hydraulic engineering measures, position of weirs and other migration barriers (with regard to fish), river morphology (transects, river structures...) etc. usually represent the basic information contained by RMP's. Unfortunately data from existing RMP's widely lack harmonisation of terminologies and topics. For example the vegetation layers for the RMP Glan and RMP Gurk were based on different assessment catalogues.

Therefore within the two exemplary case studies most data had to be treated as single data sets ("unstructured geo-data") within the GIS project that was created for this analysis. Meta-information for these heterogeneous data sets were available as textual reports respectively as project files (e.g. ESRI *.mxd, *.apr or AUTODESK *.dwg). In a first step inquiries to data quality (spatial quality, field- and attribute lists) and information content for each work-package had to be done. In a second step the minimum requirements for each SDE-feature class had to be established.

Each SDE-feature class is described by a CODE for numeric information and a DESCRIPTION for textual information. Additionally a WIS-ID is set, working as a foreign key to the water information system of Carinthia, where the meta information for work packages of the RMP's is stored.

All these SDE-feature classes were implemented in an ESRI-ArcIMS-Service, based on an AXL configuration file. In the WMS administrator console of ArcIMS the ESRI-ArcIMS-Service was additionally enabled to handle OGC-WMS requests, which represents an open standard of the Open-GIS-Consortium.

At the moment meta-information only can be retrieved through the government's Intranet. SDE-features were generated only for data representing the current situation of vegetation and river morphology. In a next phase the integration of the proposed management measures and other important spatial information is planned.

Three types of data access were investigated (Fig. 4):

- 1) ArcMAP using the proprietary ESRI-ArcIMS-Service (Fig. 5)
- 2) ArcMAP using an OGC compatible WMS-Service (Fig. 6)
- 3) Web-application "Kärnten Atlas" based on HTML and JavaScript using the proprietary ESRI-ArcIMS-Service

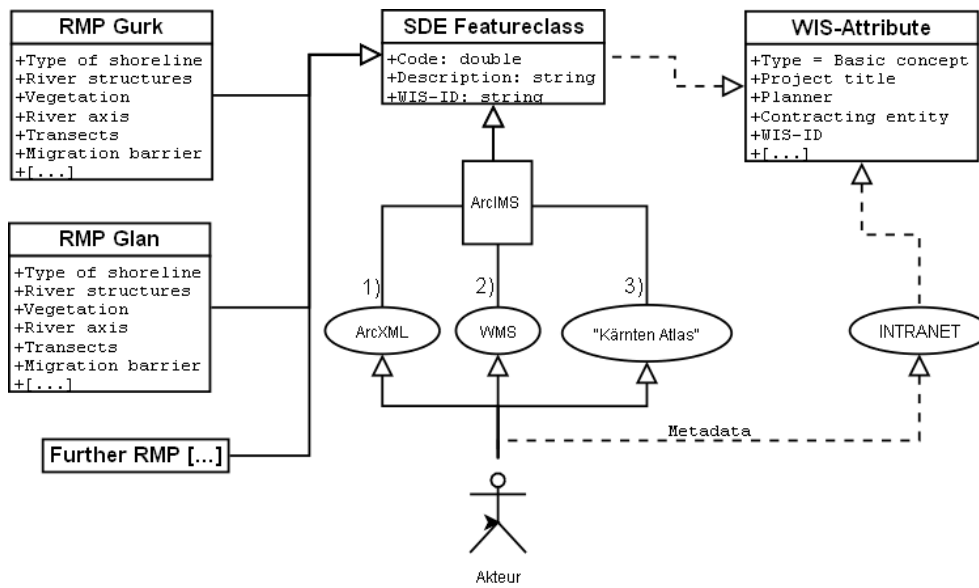


Fig. 4: Data flow and processing using the ESRI ArcIMS web service “fb_projekte”.

Besides testing the potential of the OGC compatible WMS-Service and the Kärnten Atlas for data transfer and combination, the main aim of the test was to investigate if local spatial data could be intersected with spatial data coming from an ArcIMS-Service. To test this functionality within an ArcMAP-client a local shape file “habitat“ had to be created.

It was necessary that both, the ArcIMS Service and the local shape file were loaded to an ArcMAP Session. Afterwards, local data and ArcIMS-Layers were put into the “Intersect-dialog” of the ArcTool-Box with drag&drop. The result was a new local dataset with all attributes of the ArcIMS-Layer.

Up to now both the WMS- and ArcIMS Service are defined as non-restricted services being accessible without any limitation to the number of users or the amount of transferred features. But as the service is targeting specific users groups, it will be restricted in future. Further details on the services used are shown in Tab. 2.

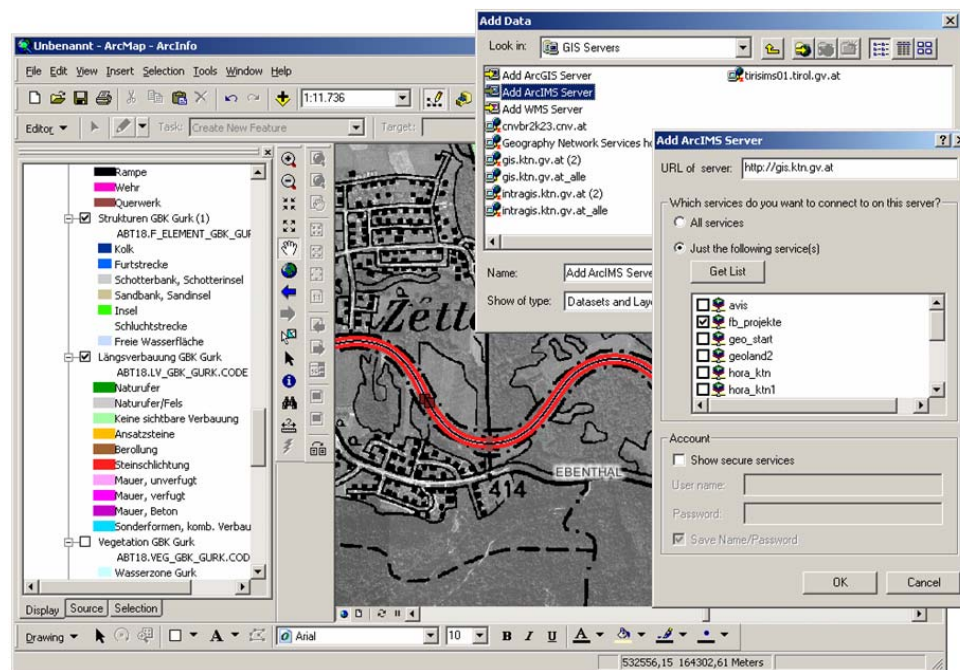


Fig. 5: Adding the ArcIMS service “fb_projekte” in ArcMAP.

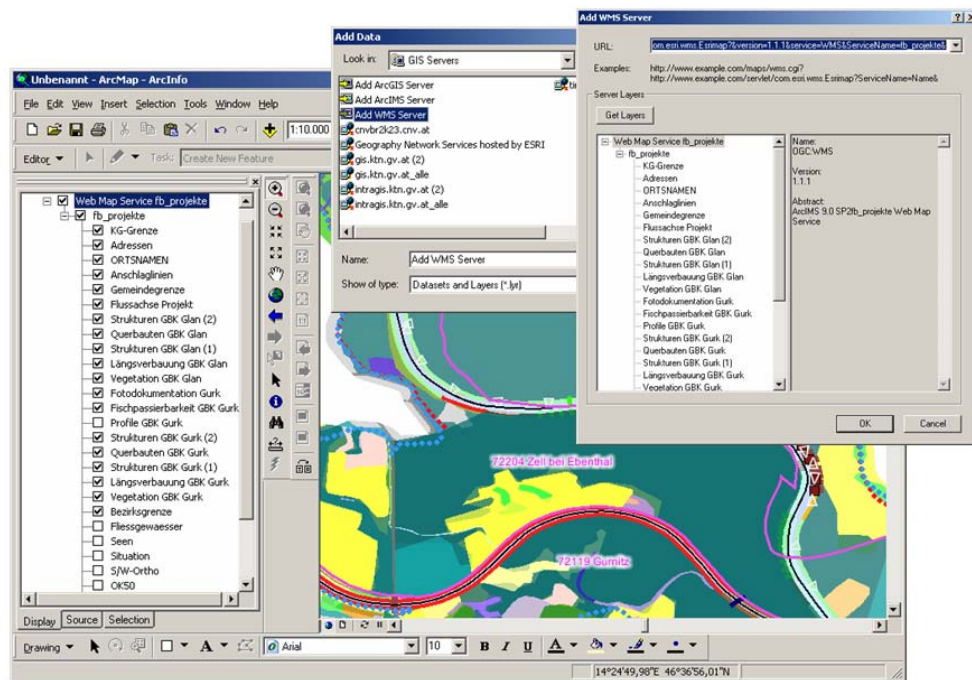


Fig. 6: Adding the OGC-WMS service „fb_projekte“ in ArcMAP.

Tab. 2: Description of services tested within the current project.

URL to add ArcIMS-Service to ArcMAP	ArcIMS service
http://gis.ktn.gv.at	fb_projekte
URLs to manage WMS requests	WMS parameters
http://gis.ktn.gv.at/wmsconnector/com.esri.wms.Esrimap?version=1.1.1&service=WMS&ServiceName=fb_projekte&request=getcapabilities	GetCapabilities
http://gis.ktn.gv.at/wmsconnector/com.esri.wms.Esrimap?version=1.1.1&service=WMS&ServiceName=fb_projekte	URL to access the WMS-Service in ArcMAP
URL to open the „Kärnten-Atlas“	
http://gis.ktn.gv.at/atlas/init.aspx?ks=wa&karte=fb	

4 Results

Within the tests expectedly clear differences between the services with regard to data transfer and processing were found (Tab. 3)

Tab. 3: Tested actions and results for three different web-map services.

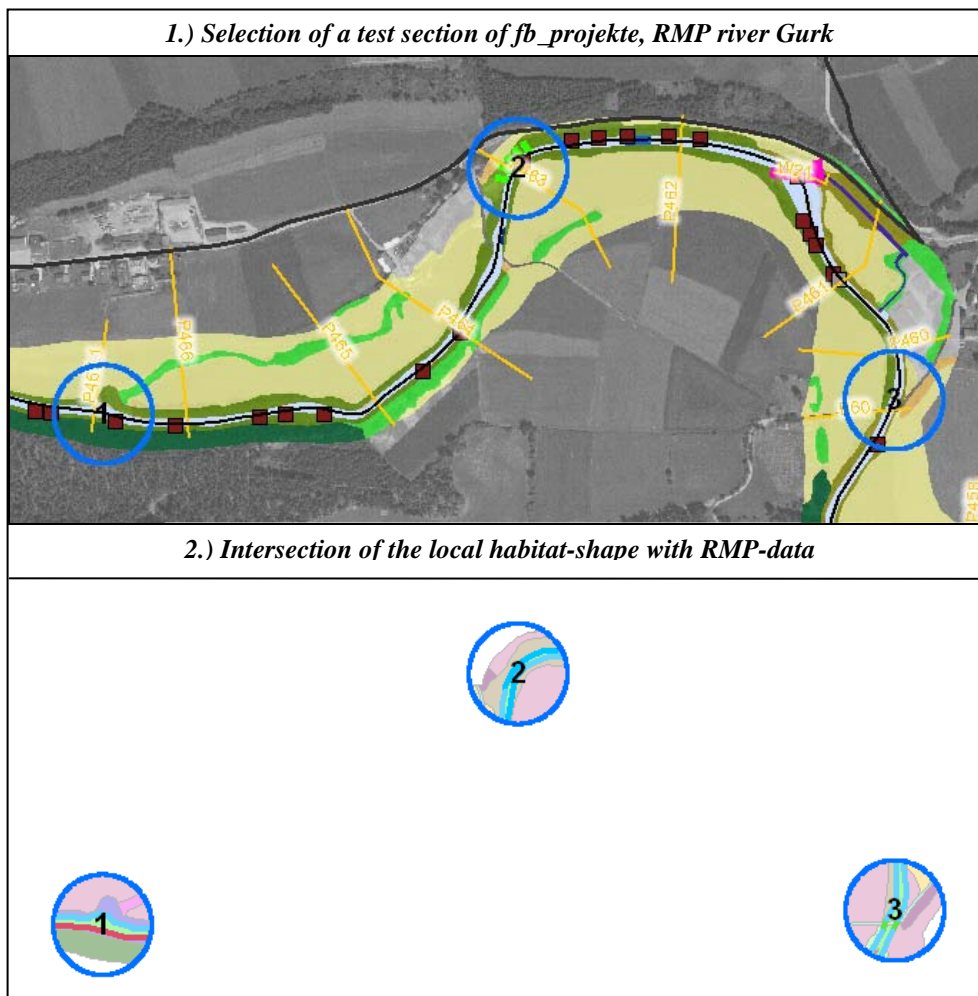
Service	Action (tested)	Result
ArcMAP using the proprietary ESRI-ArcIMS-Service	Add Service to ArcMAP, map request (GET_IMAGE), feature queries (GET_FEATURE), overlay functions CLIP and INTERSECT for a local combination of service-layers and local datasets.	Retrieval of images and large feature queries. Local overlay results containing detailed feature information; high potential for further processing.
ArcMAP using an OGC compatible WMS-Service	Add Service to ArcMAP, request of map (GetMap) and feature information (GetFeatureInfo)	Retrieval of images and single feature information; no attribute queries of complete feature sets, limited potential for further processing.
"Kärnten Atlas" using the proprietary ESRI-ArcIMS-Service	Navigating through different map collections containing information to one test area; predefined attribute queries; linear and area measurements.	Feature lengths and areas, HTML/PDF output of maps, collection of maps representing a variety of data of the same area; no potential for further processing of data within a GIS.

ArcXML (ESRI-ArcIMS-Service)

Using the proprietary ESRI-ArcIMS-Service, data could be used by a client nearly like local data and processed locally with the overlay-function (Fig. 7). Data transferred were vegetation and shoreline type. The only problem that occurred during the first tests, was the incompatibility of the MS Explorer 07 with ArcGIS 9.0 resulting in computer crashes.

WMS

Requests like GetMap and GetFeatureInfo allow the retrieval of images (gif/png/jpg) and single feature-information (comparable with the Info-button of a Desktop-GIS). "Attribute Queries" of complete feature-datasets are not supported by WMS. Legends are an optional part of the WMS-standard. Accordingly the potential to analyse data with WMS-services is limited.



overview of several fields in a planning area. At this time about 50 services are assigned to about 10 map collections.

5 Discussion

Testing different web-map services for transferring unstructured data from two exemplary RMP's yielded a clear picture of how data and techniques used might contribute to the implementation of the EU-WFD. Especially the ESRI ArcIMS service was found to offer a variety of possibilities of data transfer and analysis. Data from the server at the Provincial Government of Carinthia were intersected with local layers and all features and attributes were made available for further local processing. This service therefore can strongly be recommended for situations where data retrieval and further local processing is of high relevance (e.g. for planners, hydraulic engineers, scientists). To fulfil the requirements of the WFD and INSPIRE generally the application of standardised web-map services (WMS/WFS) based on open source solutions is strongly recommended, because only within a true Spatial Data Infrastructure (SDI) of all relevant data, interdisciplinary planning can be successful (FORNEFELD et al., 2004). Although the lack of standardisation of terminologies and topics within the existing RMP's still does not allow for standardised open source approaches, the relevance of spatial data from existing RMP's for the implementation of the WFD on a spatial explicit level (e.g. water bodies) is considered to be very high. The spatial explicit information on important pressures like connectivity interruptions (weirs), bad morphological situation of the river bed or land use within the potential floodplain represents crucial information for a WFD-consistent restoration process of aquatic ecosystems. As high detailed spatial information from RMP's is available for more than 41% of the riverine network with >100 km² catchment area of the national planning area "Drau", this information is also of high relevance for other stakeholders on a Federal State level (e.g. urban and regional planning, planning companies, citizen initiatives, scientists). Future efforts should focus on a standardisation of the available spatial RMP-data to allow for basin-wide analyses, generalisation of information and finally the development of open source WFS and WMS-services for a standardised combination with data from other sources, e.g. information of pressures and ecological status on a water body scale from ongoing field activities and the ecological status monitoring programme, within a true open source SDI.

6 Acknowledgements

The authors thank Thomas Piechl and Stephan Schober (Provincial Government of Carinthia, Dept. 18 – Water Management) for helpful comments and fruitful discussion on the technical implementation of the web-map-services and the implementation of the WFD on the Federal State level. We would also like to thank Helena Mühlmann, Federal Agency for Water Management, Institute for Water Quality, for significantly increasing our understanding of the political dimension of the WFD-implementation process.

7 References

ArcXML Programmer's Reference Guide in HTML, 2005 ESRI, http://downloads.esri.com/support/documentation/ims/ArcXML9/Support_files/arcxmlgui.de.htm (19.01.2007).

BMLFUW, 2005a. EU-Wasserrahmenrichtlinie 2000/60/EG Österreichischer Bericht über die IST-Bestandsaufnahme. Wien. BMLFUW. 205.

BMLFUW, 2005b. Wasserrechtsgesetz 1959 idF BGBl. I Nr. 87/2005. Vienna. BMLFUW. 141.

BMLFUW, 2006. TECHNISCHE RICHTLINIEN für die Bundeswasserbauverwaltung RIWA-T gemäß § 3 Abs. 2 WBFVG. Vienna. 61.

COWX, I. G. and M. J. COLLARES-PEREIRA, 2002. Freshwater fish conservation: options for the future. Freshwater Fish Conservation - Options for the Future. M. M. Coelho, Ed. Oxford, Fishing News Books: 443-452.

DELPEUCH, B., 2002. Foreword. Freshwater Fish Conservation - Options for the Future. M. M. Coelho, Ed. Oxford, Fishing News Books - Blackwell Science: vii-viii.

DIETRICH, J. and A. SCHUMANN, Eds. 2006. Werkzeuge für das integrierte Flussgebietsmanagement. Konzepte für eine nachhaltige Entwicklung einer Flusslandschaft. Berlin, Weißensee Verlag.

EC, 2003. Implementing the geographical information systems elements (GIS) of the Water Framework Directive. Common Implementation Strategy for the Water Framework Directive (2000/60/EC). 9. Luxembourg, Office for Official Publications of the European Communities. 156.

FORNEFELD, M., P. OEFINGER and K. JAENICKE 2004. Nutzen von Geodateninfrastrukturen. <http://www.micus.de/>, 22.01.2007. MICUS Management Consulting GmbH. 87.

MICHOR, K. and H. HOFFERT, 2003. Gewässerbetreuungskonzepte als Planungsinstrument auch für LIFE-Projekte. 20. Flussbautagung, LIFE – SYMPOSIUM Gewässerbetreuung und die EU-Wasserrahmenrichtlinie – Umsetzung am Beispiel von LIFE Projekten“, Spittal / Drau. BMLFUW: 113-126.

STALZER, W., 1994. Gewässerbetreuungskonzepte- Stand und Perspektiven. Wiener Mitteilungen. 120. Wien, BMLF. 1-14.

URL-1. <http://www.euwfd.com>, 19.01.07.

URL-2. <http://ec.europa.eu/environment/nature/home.htm> (19.01.07).

URL-3. <http://www.waterframeworkdirective.wdd.moa.gov.cy/guidance.html> (19.01.07).

URL-4. <http://www.austria.gv.at/DocView.axd?CobId=19542> (28.01.07).

URL-5. <http://wise.jrc.cec.eu.int/wfdview/php/index.php> (19.01.07).

URL-6. http://gis.lebensministerium.at/wisa/frames/index.php?&gui_id=WisaStandard, (30.04.07).

WFD, 2000. DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000 establishing a framework for Community action in the field of water policy.

Web Map Service Implementation Specification, Open GIS Consortium Inc., Version: 1.1.1, Reference number of this OpenGIS® project document: OGC 01-068r3 http://portal.opengeospatial.org/files/index.php?artifact_id=1081&version=1&format=pdf (19.01.2007).