

ZASNOVA INTEGRIRANEGA EKSPERTNEGA INFORMACIJSKEGA SISTEMA ZA UPRAVLJANJE Z VODAMI V SLOVENIJI THE CONCEPT OF INTEGRATED EXPERT INFORMATION SYSTEM FOR WATER MANAGEMENT PLANNING IN SLOVENIA

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V Sloveniji se razvija sistem usklajenih podatkov in drugih informacij o vodah in na vodo vezanih elementov. Sistem bo podporno orodje za načrtovanje upravljanja z vodami. Sestavljajo ga preverjeni podatki in agregirane, logično integrirane informacije o stanju voda v Sloveniji, pritiskih in vplivih na vodno okolje in varstva voda. Podatkovni viri so nacionalne podatkovne evidence in sistemi spremljanja stanja. Koncept smo razvili na prototipu. Sestavljen je iz neodvisnih informacijskih tematskih slojev, ki so organizirani po principih geografskih informacijskih sistemov in pripravljene za brskanje po notranji in zunanji elektronski mreži.

Ključne besede: informacijski sistemi, podatkovne baze, upravljanje z vodami, načrtovanje upravljanja z vodami

In Slovenia, the system of harmonized data and other information on water and water related areas is being developed as a support tool for water management planning. The system includes verified data and aggregated and logically integrated information on the state of waters in Slovenia, the pressures and impacts on water environments, and their protection. National information evidence and monitoring systems provide the data sources. The concept has been developed by way of a prototype. The system consists of independent data, organized by information themes with the logic of geographic information systems and prepared for browsing with intranet and internet.

Key words: information system, data base, water management, water management planning

1. UVOD

Informacije o vodah Slovenije iščejo eksperti, upravni delavci, javnost, politiki, mednarodne institucije in podobno. Informacije morajo biti lahko dostopne, zanesljive in primerne za več namenov, to je analize vodnega okolja, poročanja o stanju voda ter za načrtovanje upravljanja z vodami za državni in evropski nivo, kot ga predpisuje Direktiva 2000/60/ES Evropskega parlamenta in Sveta, ki določa okvir za delovanje Skupnosti na področju vodne politike (Vodna direktiva).

Informacijski sistem, do katerega lahko dostopajo naenkrat vsi potencialni uporabniki, je sistem, ki je lociran na medmrežju. Negash s sodelavci (2003) ugotavlja, da je kakovost in učinkovitost informacijskih podpornih sistemov na medmrežju odvisna predvsem od

1. INTRODUCTION

The information of Slovenian waters are required by experts, administrative workers, the public, politicians, international institutions etc. The information should be easily accessible, reliable and suitable for the purpose of analyzing the water environment, reporting about the state of water and for water management planning at the national and European levels as proposed by the Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for Community action in the field of water policy (Water Framework Directive).

The information system that should be accessed by all potential users is located in the internet. Negash et al. (2003) has established that quality and efficiency of information support system in the internet depends mainly

informacij in kakovosti sistema, manj od kakovosti strežnikov. Zato je pozornost treba nameniti ravno pripravi ustreznih informacij in njihovi organizaciji.

Celovito načrtovanje rabe vodnih virov in varstva voda je osnovano na podatkih o hidroloških, kemičnih in ekoloških lastnosti vode ter na informacijah o vplivih obremenitev (raba vode in dejavnosti v vodnem prostoru, onesnaževanje voda) na vodno okolje, prihodnjih potrebah in možnih navzkrižjih. Podatke iz različnih virov, medsebojno neuskklajenih, je zato treba združiti in logično uskladiti do najvišjega možnega nivoja in pripraviti za hiter in enostaven dostop preko medmrežja. Velikost elektronskega zapisa podatkov naj bi bila čim manjša, da je omogočen hiter prenos med strežnikom in uporabnikom.

V članku je predstavljena zasnova strukture informacijskega sistema, ki omogoča dostop do podatkov preko medmrežja in služi za pripravo načrtov upravljanja z vodami v Sloveniji, kot ga uvaja Vodna direktiva (Directive 2000/60/EC). Opisan je prototip sistema, ki je narejen po predlagani zasnovi.

2. METODE DE LA

Najprej je bil izdelan seznam informacijskih tem, vezanih na vode. Nato so bili zbrani razpoložljivi podatki. Podatke se je prostorsko poenotilo. S pomočjo teh podatkov je bil izdelan prototip informacijskega sistema, do katerega je omogočen dostop na medmrežju, podatki pa so vsebinsko dobro pregledni in enostavni za prenose. Na podlagi izkušenj pri razvoju prototipa se je zasnova logika delovanja ekspertnega informacijskega sistema za načrtovanje upravljanja z vodami. Glede na smernice izvajanja Vodne direktive (European Commission, 2002; 2003) sta bila izdelana seznama potrebnih podatkov za ekspertni informacijski sistem in osnovnih podatkovnih virov.

Informacijske teme so opredeljene in organizirane v modulih DPSIR (Driving forces, Pressure, Status, Impact, Response), kar po slovensko pomeni: gonilne sile, pritiski, stanje, vplivi, odziv. Taka opredelitev

on the data and quality of the system and less on the quality of servers. Thus, great attention should be given to the preparation of suitable data and their organization.

The integral planning of water resources use and environmental protection is based on information on hydrological, chemical, ecological characteristics of water and on impacts of pressures (water use and activities in the water environment, pollution) to the water environment, future needs and possible conflicts. Hence, data from different and heterogeneous sources should be aggregated and harmonized at a higher level and prepared for a fast and easy access. The size of the electronic storage of data should be kept to a minimum, in order to enable a fast transfer between the server and the user.

The article represents a design of the information system structure, enabling access to data via the internet and thus facilitating the preparation of water management plans in Slovenia, as laid down by the Water Framework Directive (Directive 2000/60/EC). A prototype system is described, based on the proposed design.

2. METHODS OF WORK

First we set up a list of information themes, related to waters. Then the available data were collected. The data were spatially harmonized. By the use of these data a prototype of the information system was made that enabled the internet access, and these data were well organized and in easily downloadable. Based on the experiences gained during the development of the prototype, the logic of expert information system operation for water management planning was proposed. According to the guidelines of the Water Framework Directive (European Commission, 2002; 2003) two lists of necessary data for the expert information system and basic data bases were prepared.

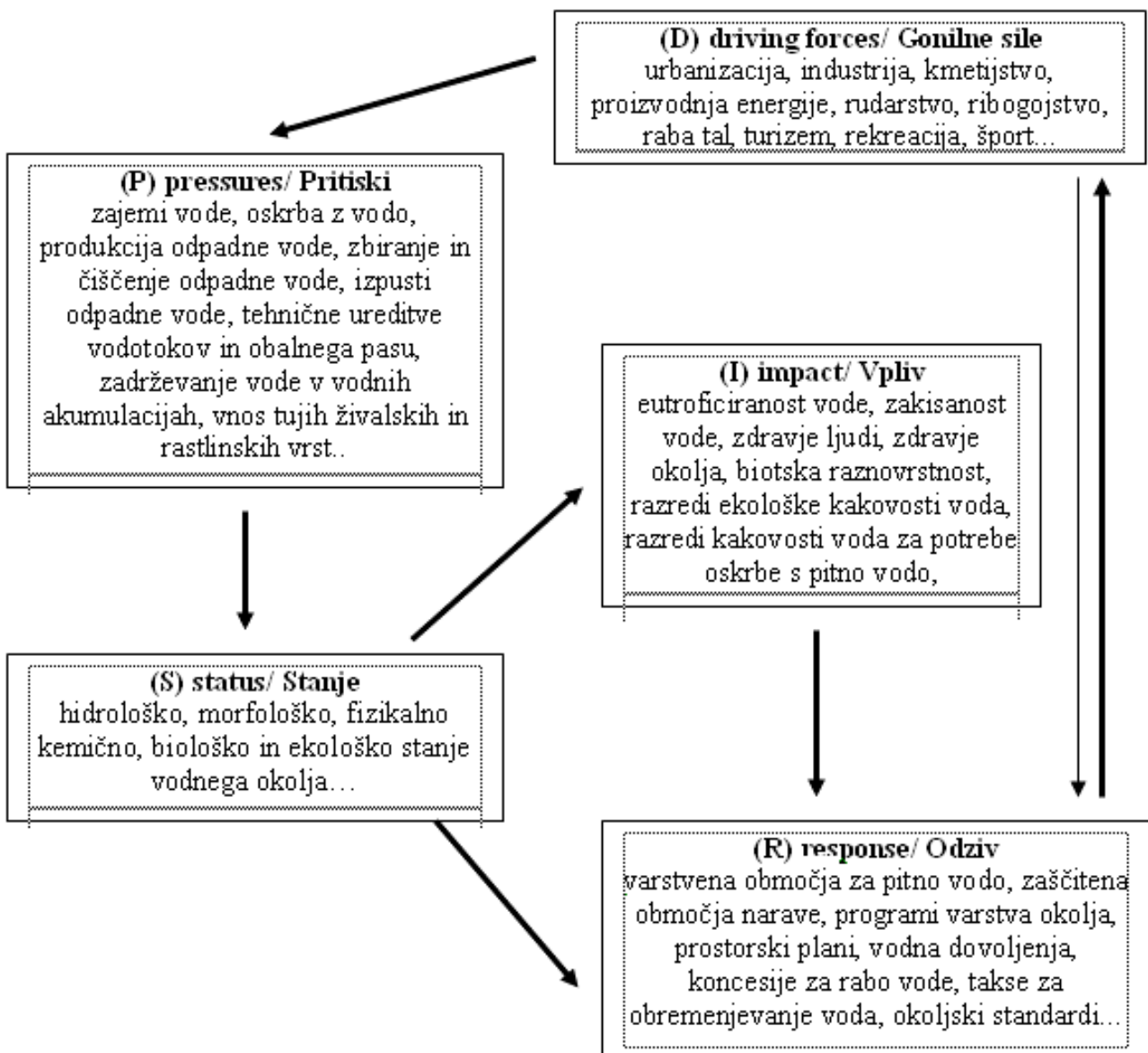
The information themes are defined and organised by the DPSIR modules (Driving forces, Pressure, Status, Impact, Response), as have been previously applied for the marine environment (EEA, 1999). However, such data

modulov okolja je bila uporabljena že pri analizi morskega okolja (EEA, 1999). Uporablja se tudi pri analizi drugih delov okolja. Odnose med moduli DPSIR in seznam možnih informacijskih tem v modulih, ki se navezujejo na okolje celinskih voda, prikazuje slika 1.

Izbor informacijskih tem za vsak modul je odvisen od obstoječih podatkov o vodah Slovenije oziroma podatkov, ki se pripravljajo za potrebe poročanja držav članic Evropske skupnosti o izvajanju Vodne direktive (EC, 2003).

content and organization is being developed also for other environmental segments. Relationships among DPSIR modules (EEA, 1999) and a list of possible information themes in the modules related to inland waters are shown in Figure 1.

The selection of information themes for each module depends on the existing data about waters in Slovenia, or on data that are being prepared for reporting on the Water Framework Directive implementation in the member states of the European Union (EC, 2003).



Slika 1. Odnosi med moduli DPSIR (EEA, 1999) in spisek možnih tem v modulih, ki se navezujejo na vode.

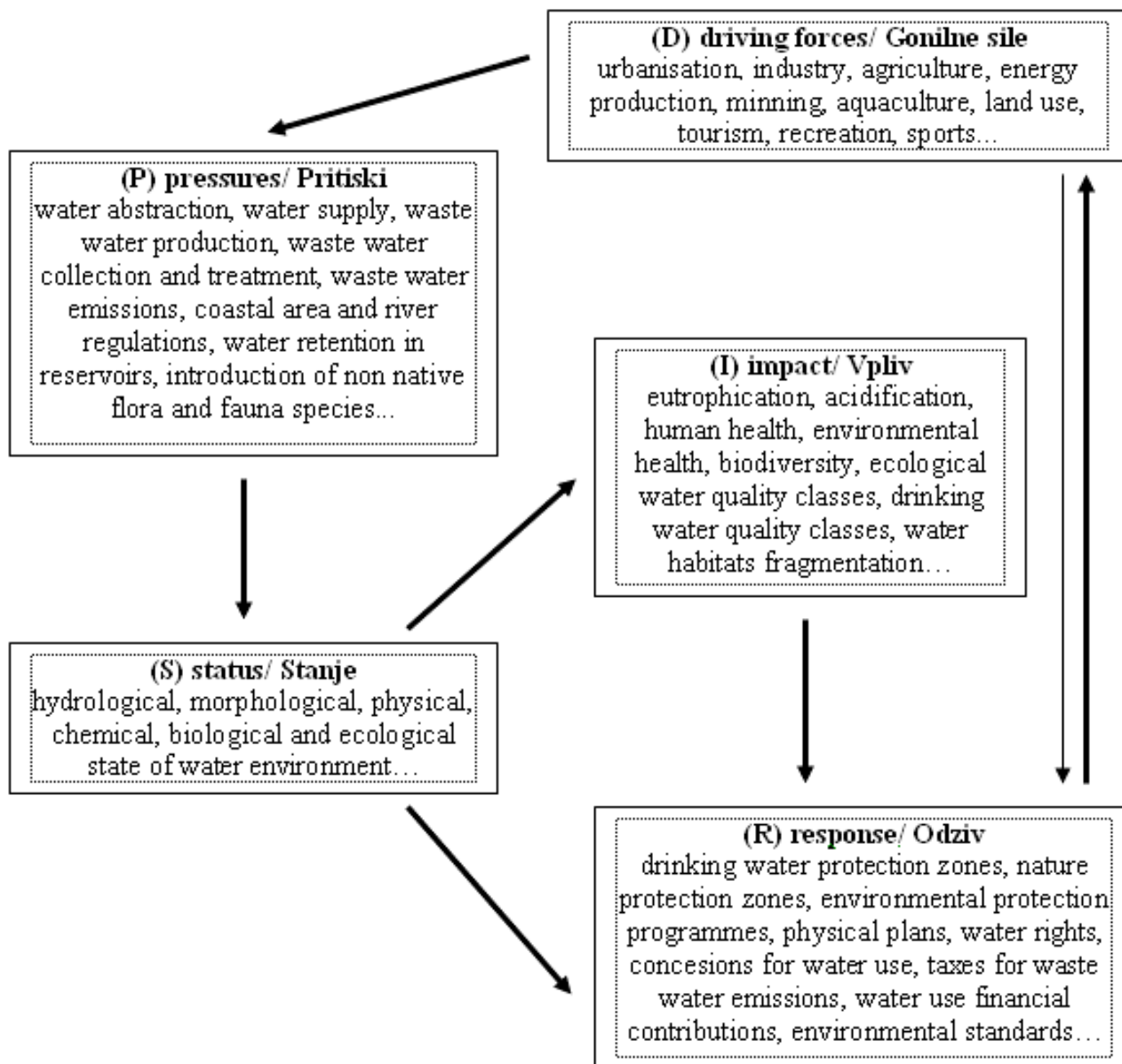


Figure 1. The relations among DPSIR modules (EEA, 1999) and possible information themes in each module in relation to water.

Podatki, ki jih je možno pridobiti v Sloveniji:

- gonilne sile in pritiski: naselja s številom prebivalcev, lokacije proizvodnje elektrike iz vodne energije, področja turističnih in rekreacijskih aktivnosti na vodah, ribogojnice, območja kanalizacijskih in vodovodnih sistemov, lokacije točkovnih virov onesnaževanja (iz industrije, čistilnih naprav, deponij, rudarjenja), raba tal, vodni zadrževalniki, visoke pregrade, visokovodni nasipi;
- stanje in vplivi: količine vode na lokacijah hidrološkega monitoringa, kakovost vode,

In Slovenia, these are:

- Driving forces and pressures: settlements with population, water energy production, tourist and recreational activities on waters, fish farms, sewerage and drinking water supply areas, location of point pollution sources (emissions from industry, waste water treatment plants, landfill sites, mining), land use, water reservoirs, large dams; high water flow protection dikes;
- State and impact: water volume in hydrological monitoring sites, water quality, erosion areas, eutrophication areas, hydromorphological classification of rivers, flood areas.

erozijska območja, evtrofikacijska območja, hidromorfološka kategorizacija vodotokov, poplavne površine;

- odziv: varstvena območja za pitno vodo, zaščitena območja narave, vodna povračila, takse za obremenjevanje voda.

Izbrane podatke, ki se lahko nahajajo v tabelarični, slikovni, tekstovni ali geografski obliki, se je združilo v izbrani informacijski sloj glede na temo. Vsak informacijski sloj je tako postal neodvisna podatkovna baza.

V posamezen informacijski sloj prototipa so vključeni vsi v tistem trenutku razpoložljivi podatki o tematiki. Geografski podatki enega informacijskega tematskega sloja so se uskladili z ostalimi geografskimi podatki in pripravili za GIS-okolje. V ta namen se je uporabil programski paket AutoDesk MAP.

Za izhodiščno geografsko podatkovno bazo je bila izbrana baza hidrografskih območij z ustreznim kodnim sistemom (Brilly, 1996; Šraj in Brilly, 2000). Geografski podatki te baze namreč prostorsko opredelijo celotno območje Slovenije glede na prispevne površine rek. Informacijski sloj rek vsebuje linijske objekte kartografske baze podatkov za vode (hidrografija) GKB25-H (Geodetska uprava Republike Slovenije, 2003). Za potrebe razvoja prototipa so se pozicije poligonskih objektov baze hidrografskih območij poenotile s pozicijami ustreznih vozlišč linijskih objektov baze GKB25-H.

V prototip modela so vključeni vsi podatki o vodah, ki so bili pripravljene v projektih Vodnogospodarskega inštituta (VGI, 1997; 2000; 2001) in Vahtar in ostali (2000). Vključili smo tudi podatke o stanju voda v Sloveniji, ki so bili pripravljene v programu 'PHARE TOPIC LINK/INLAND WATER' Evropske agencije za okolje (Feher in ostali, 2001). S tem so bile upoštevane tehnične smernice Evropske agencije za okolje (EEA, 1998) za poročanje o stanju voda. Te smernice podajajo naslednje kriterije za izbor in organizacijo podatkov:

1. Kopensko vodno okolje je razdeljeno na tri kategorije: reke, jezera, podzemne vode.
2. Podatke o kakovosti in karakterističnem pretoku rek se Evropski agenciji za okolje pošilja za lokacije, ki so v državni mreži monitoringa. Izbor lokacij monitoringa je

- Response: drinking water protection zones, nature protection areas, water use financial contributions, charges for waste water emissions.

The chosen data, given either in tabular, graphical, textual or geographical formats, were grouped into information layers related to their theme. Each information layer thus became an independent data base.

In each information layer of the prototype all currently available data on the given theme are included. Geographic data of one information thematic layer were harmonized with other geographic data and prepared for the GIS environment. For this purpose the AutoDesk MAP program package was used.

For the basis of the geographic data base a data base of hydrographic areas with their corresponding coding system was chosen (Brilly, 1996; Šraj and Brilly, 2000). Based on these geographic data, the entire area of Slovenia is defined spatially according to the size of watersheds. The information layer of rivers contains lineal objects of the cartographic data base for waters (hydrography) GKB25-H (Geodetska uprava Republike Slovenije, 2003). When developing the prototype the positions of polygonal objects of the data base of hydrographic areas were unified with the positions of adequate hubs of lineal objects of the GKB25-H data base.

In the prototype, we included data on waters, which have been prepared within the projects of the Water Management Institute, Ljubljana (VGI, 1997; 2000; 2001), and Vahtar et al. (2000). We have included also data on water status in Slovenia, prepared within the 'PHARE TOPIC LINK/INLAND WATER' program of European Environmental Agency (Feher et al., 2001). Thus technical guidelines for reporting on the state of waters in the member states of the European Environmental Agency (EEA, 1998) have been considered. These guidelines give the following criteria for data selection and organisation:

1. The water environment is divided into three categories: rivers, lakes, ground water.
2. Monitoring locations on rivers, for which water quality and quantity data are reported to the EEA, are chosen from the

odvisen od velikosti prispevnih površin. Velikosti prispevnih površin so enakomerno razporejene od majhnih do največjih. Majhne prispevne površine so tiste, ki imajo velikost večjo od 50 km², srednje med 51 in 250 km², velike med 251 in 1.000 km², zelo velike med 1.000 do 2.500 km² in največje nad 25.000 km².

3. Najmanjše število lokacij na rekah ali jezerih za katere se poroča Evropski agenciji za okolje je odvisno od velikosti države (ena lokacija na vsakih 1.000 km² površine).

Poleg na vodo vezanih tematskih informacijskih slojev smo v prototip vključili še naslednje podatke: meje občine, katastrskih občin in upravnih enot (administrativne enote), centroide naselij in lokacije državnega monitoringa kakovosti rek.

3. REZULTATI

3.1 PROTOTIP

Preglednica 1 podaja seznam 31 tematskih slojev, ki so bili pripravljani in vgrajeni v prototip s posebno logično organizacijsko strukturo podatkov. Z zvezdico so označene oblike zapisov podatkov, ki jih vsebuje tema. Večina prostorskih podatkov je pripravljenih v vektorski obliki (Gauss Krügerjev koordinatni sistem). Ostali podatki so pripravljani v slikovni (raster), tabelarni ali tekstovni obliki.

Vsak tematski sloj ima rastersko sliko za hiter pregled vsebin sloja. Tabelarni podatki v obliki XLS (MS Excel) so pripravljani za 14 tematskih sklopov, 2 imata tekstovno obliko DOC (MS Word). Relacijske podatkovne baze so pripravljene v obliki MDB (MS Access) in narejene za 12 tematskih slojev. Med relacijsko podatkovno bazo in topološkimi elementi prostorske baze je že pripravljena povezava ('link'), tako da lahko s pomočjo GIS-orodij v programu AutoCad MAP izvajamo prostorske analize.

national monitoring system. Selection of a monitoring location depends on the catchment area. The sizes of catchments are distributed from small to the largest. Small ones are those that have a catchment area smaller than 50 km², medium ones between 51 and 250 km², large between 251 and 1000 km², very large between 1,000 and 2,500 km² and the largest ones over 2,500 km².

3. The minimum number of monitoring stations on rivers, for which data should be reported to the EEA, depends on country size (one monitoring station goes for each 1,000 km²).

Besides the thematic information layers related to water the following data were included in the prototype: boundaries of communities, cadastral communities and administrative units, centroids of settlements and locations of the state monitoring of water quality.

3. RESULTS

3.1 PROTOTYPE

Table 1 presents the list of 31 thematic layers that have been prepared and built into the prototype with a unique logical organization of data. The asterisk stands for different forms of data that are included into one theme. The majority of spatial data is prepared in vector form (Gauss Krüger co-ordination system). Non spatial data are presented in graphical (raster), tabular or textual forms.

Each thematic layer has a raster picture for quick view of the content of the layer. Tabular data in XLS (MS Excel) format are prepared for 14 thematic layers, 2 have textual format DOC (MS Word). Relational data bases in the MDB format (MS Access) format are prepared for 12 thematic layers. Between the relational data base and topological elements of spatial data base a link is prepared ('link'). With the GIS tools in the AutoCad MAP program, we can perform spatial analysis.

Preglednica 1. Informacijski tematski sloji.

	Informacijski tematski sloji	INTRANET+GIS					
		INTERNET					
		tip datoteke*					
		DWF	JPG	XLS	DOC	MDB	DWG
	SPLOŠNO						
1	Reke	*	*			*	*
2	Hidrografska območja in razvodnice	*	*	*		*	*
3	Povodja in porečja	*	*				*
4	Jezera	*	*				*
5	Podzemne vode	*	*				*
6	Mokrišča	*	*	*		*	*
7	Hidrogeološke lastnosti	*	*			*	*
8	Morje	*	*				*
9	Vodni izviri	*	*			*	*
10	Občine	*	*	*		*	*
11	Upravne enote						
12	Vodnogospodarska območja	*	*				*
13	Relief		*				
	GONILNE SILE						
14	Melioracije	*	*				*
15	Kopanje na naravnih vodah	*	*	*		*	*
16	Raba tal/Pokrovnost CLC95	*	*	*		*	*
17	Naselja	*	*	*			*
	PRITISKI						
18	Območja kanalizacijskih sistemov	*	*				*
19	Območja vodovodnih sistemov	*	*				*
20	Komunalne čistilne naprave	*	*				*
	STANJE						
21	Minimalni specifični pretoki	*	*				*
22	Poplavne površine	*	*				*
23	Letne padavine		*				
24	Kakovost rek na lokacijah za poročanje na EEA	*	*	*			*
25	Kakovost podzemnih voda na lokacijah za poročanje na EEA	*	*	*	*		*
26	Kakovost jezer na lokacijah za poročanje na EEA	*	*	*			*
	VPLIV						
27	Skupna ocena kakovosti rek	*	*	*			*
	ODZIV						
28	Zavarovana območja narave	*	*	*		*	*
29	Zavarovani vodni viri	*	*	*		*	*
30	Vodovarstvena območja	*	*	*		*	*
31	Občutljiva območja	*	*		*		*

*DWF – Drawing WEB Free Format: lahka oblika zapisa grafičnih entitet s programi AutoDesk; DWG – Drawing Format: oblika zapisa grafičnih entitet s programi AutoDesk; JPG – JPEG-JFIF: rastrska oblika zapisa slike; DOC – tekstovna oblika datoteke, zapisana v programu Word (Microsoft Office97); XLS – tabelarična oblika datoteke, zapisana v programu Excel (Microsoft Office97); MDB – Relacijska podatkovna baza, zapisana s programom Access 97 (Microsoft Office97).

Table 1. Information thematic layers.

	Information thematic layer	INTRANET+GIS					
		INTERNET					
		type of file*					
		DWF	JPG	XLS	DOC	MDB	DWG
	GENERAL						
1	Rivers	*	*			*	*
2	Hydrographic areas and watershed lines	*	*	*		*	*
3	Catchment areas	*	*				*
4	Lakes	*	*				*
5	Groundwater	*	*				*
6	Wetlands	*	*	*		*	*
7	Hydro geological characteristics	*	*			*	*
8	Sea	*	*				*
9	Water springs	*	*			*	*
10	Local community districts	*	*	*		*	*
11	Administrative units						
12	Water management areas	*	*				*
13	3D terrain		*				
	DRIVING FORCES						
14	Areas with drainage system	*	*				*
15	Bathing on natural waters	*	*	*		*	*
16	Corine Land Cover 95	*	*	*		*	*
17	Settlements	*	*	*			*
	PRESSURES						
18	Ares with sewerage systems	*	*				*
19	Water supply areas	*	*				*
20	Municipal Waste Water Treatment Plants	*	*				*
	STATE						
21	Minimal annual specific discharges	*	*				*
22	Flood areas	*	*				*
23	Annual precipitation		*				
24	Monitoring stations on rivers for reporting to EEA	*	*	*			*
25	Monitoring Stations on ground Water for reporting to EEA	*	*	*	*		*
26	Monitoring Stations on lakes for reporting to EEA	*	*	*			*
	IMPACT						
27	Combined estimate of river quality	*	*	*			*
	RESPONSE						
28	Nature protection areas	*	*	*		*	*
29	Protected water sources for drinking water	*	*	*		*	*
30	Drinking water protection zones	*	*	*		*	*
31	Surface water vulnerable areas	*	*		*		*

***DWF** – Drawing WEB Free Format: simple graphic entities formed by AutoDesk software; **DWG** – AutoDESK Drawing Format: full graphic entities formed by Auto Desk software; **JPG** – JPEG-JFIF Compliant Raster Graphic Format; **DOC** – Microsoft Office97 Document Format; **XLS** – Microsoft Office97 Spreadsheet Format: Tables; **MDB** – Microsoft Office97 Database Format: Relational data base in MS ACCESS 97 environment

Podatke, spravljene v formatih DWF, JPG, XLS in DOC, lahko pregledujemo in prenašamo po medmrežju. Za ta namen so pripravljene HTTP-moduli. Za hitrejšo izmenjavo podatkov na mreži so prostorski podatki opremljeni z manjšim številom grafičnih atributov (DWF-format). Iskanje in pregledovanje XLS- in DOC-datotek je enostavno za vsakega uporabnika, saj so datoteke pripravljene v programih Excel ali Word, ki sta v Sloveniji splošno razširjena. Za pregledovanje datotek v obliki DWF mora uporabnik imeti na voljo program WHIP IT, ki ga brezplačno prenese iz medmrežja. Ta nivo dostopanja do podatkov se imenuje 'INTRANET' nivo. Z uporabo gesla ima uporabnik dostop do vseh podatkov (skupaj 135 MB). Z dvema programskima paketoma, ki vsebujeta postopke analize GIS in analize relacijskih podatkovnih baz (AutoCAD MAP 3 in ACCESS), uporabnik izvaja prostorske analize. Ta nivo dostopanja do podatkov se imenuje 'INTRANET + GIS'. Prototip je instaliran na strežniku Fakultete za gradbeništvo in geodezijo:
(<http://www.ksh.fgg.uni-lj.si/ewnsi/>).

3.2 INTEGRIRANI INFORMACIJSKI SISTEM ZA UPRAVLJANJE Z VODAMI

3.2.1 LOGIČNA ZASNOVA

Določena so naslednja izhodišča za delovanje modela:

1. Komunikacija: medmrežno streženje in notranja mreža (osebni računalniki) s kontrolo sistema (požarni zid, gesla).
2. Programska orodja: komercialni programski paketi za osebne računalnike (MS Office, AutoDesk, ArcView ...), HTL-protokoli, XML-opis podatkov z ISO-standardi za izmenjavo.
3. Pričakovati je, da bo sistem obstoječega zbiranja podatkov na državnih institucijah ostal tak, kot je, zato je pomembno:
 - a) določiti protokole izmenjave podatkov (kdo dobi kaj, kdo da kaj ...),
 - b) ponuditi jasen in razumljiv (tudi hitro dostopen) metapodatkovni zapis (katere attribute in podatkovne relacije ima sistem),
 - c) uskladiti prostorske informacije (poenotiti kodni sistem objektov in topografskih elementov).

Data, stored in DFW, JPG, XLS and DOC formats are allowed for viewing and browsing by internet. For this purpose HTTP modules are prepared. For faster data exchange in the network spatial data are equipped with a lower number of graphical attributes (DWF format). Browsing and viewing of XLS and DOC files is easy for each user, because the files are prepared in Excel and Word programs, owned almost by every user in Slovenia. When browsing the files in DWF format, a user only needs a free-of-charge program that can be downloaded from the internet (WHIP IT). This level of access to data is called the 'INTRANET' level. With the use of a password, a user has access to all data (135 MB). With two package programs that have GIS and relational data base analysis routines (AutoCAD MAP 3 and ACCESS), the user can perform spatial analysis. This level of access to data is named the 'INTRANET + GIS' level. The prototype is installed on the server under the following name:
<http://www.ksh.fgg.uni-lj.si/ewnsi/>.

3.2 INTEGRATED DATA AND INFORMATION SYSTEM

3.2.1 LOGICAL CONCEPT

There are five logistical dispositions for the system:

1. Communication: web service and internal network (PC platforms) with user control system (firewall, passwords)
2. Software tools: PC commercial software (MS Office, Oracle, ARC/VIEW, AutoDesk products ...) and use of HTL protocols and XML data description with ISO standards for spatial data exchange
3. It is expected that systems for data collection at existing state institutions will remain, therefore it is crucial to:
 - a) determine protocols for data exchange (who gets what, who gives what ...);
 - b) offer clear and understandable (easy of access) meta data description (what are attributes and data relations);
 - c) harmonize spatial relations (unified code system of objects and topographic features).

4. Informacijski sistem za vode mora biti usklajen s prostorskimi podatki in podatki objektov ostalih sektorjev (narava, zdravje, kmetijstvo, promet, energija ...).
5. Red natančnosti za državni nivo v merilu velikosti 1 : 25.000; za evropski nivo v merilu velikosti 1 : 250.000; za lokalni nivo v merilu velikosti 1 : 5.000; najprej se razvije državni nivo.

3.2.2 ZASNOVA PODATKOVNIH STRUKTUR

Podanih je 10 elementov, ki opredeljuje podatke in strukturo informacij:

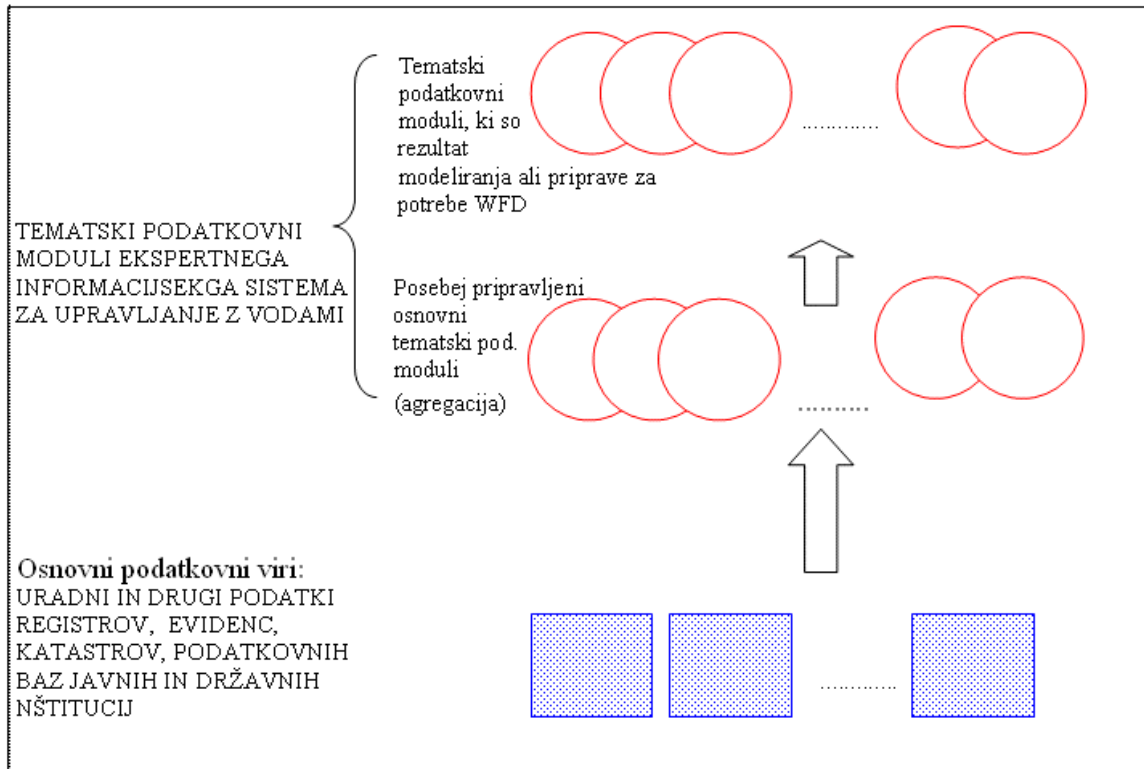
1. V sistem so vključeni podatki vseh DPSIR modulov (slika 1). Podatki so usklajeni s potrebami Vodne direktive (Directive 2000/60/EC).
2. Sistem ima tematsko neodvisne podatkovne module (v prototipu imenovane 'sloji'), ki jih sestavljajo georeferirani podatki, (prikazani na tematski karti), atributivno relacijsko podatkovno bazo in/ali opisne informacije v dokumentih, preglednicah, slikah, filmih.
3. Tematski podatkovni moduli so pripravljene kot a) agregati (združeni ali selektivno prevzeti podatki) podatkov iz osnovnih podatkovnih virov (podatki javnih ali državnih institucij) ali b) kot rezultati analiz ali modeliranja podatkov iz osnovnih podatkovnih virov za potrebe Vodne direktive (slika 2).
4. Osnovni podatkovni viri za ekspertni informacijski sistem so nacionalni podatkovni registri, evidence, katastri in ostale podatkovne baze državnih institucij.
5. Vsak tematski podatkovni modul je enkraten: podatki enega modula se ne pojavljajo v drugih moduli.
6. Vsak tematski podatkovni modul je usklajen z ostalimi in pripravljen v enotnem geografskem koordinatnem sistemu.
7. Površinske vode so predstavljene z:
 - a) DRŽAVNO TOPOGRAFSKO HIDROGRAFIJO (atributi so prevzeti iz državne hidrografske podatkovne baze GKB25).
 - b) Objekti hidrografije so kategorizirani v štiri skupine: reke, jazera, somornice, obalno morje; podatkovna baza se imenuje HIDROGRAFIJA WFD; vsak objekt dobi attribute tipologije WFD po sistemu A (Globevnik, 2000).

4. The information system for water has to be harmonised with the spatial data system and it should incorporate objects from other sectors (nature, human health, agriculture, traffic, energy ...).
5. Accuracy for state level: 1 : 25,000; EU level: 1 : 250,000; for regional level and for specific targeted programs: 1 : 5,000.

3.2.2 CONCEPT OF DATA STRUCTURE

Here are 10 descriptive elements characterizing data and information structure:

1. In the system data of all DPSIR modules are included (Figure 1). Data are consistent with Water Framework Directive (Directive 2000/60/EC).
2. The system has thematically independent data modules (in the prototype they are named 'layers') consisting of georeferenced data (shown on a thematic map), attribute relational data base(s), and/or descriptive information in documents, tables, pictures, moving slides.
3. Thematic data modules are prepared as a) aggregates (aggregated or selectively taken data) from primary data sources (data of public or state institutions) or b) as results from analysis or modeling of data from primary data sources for WFD needs (Figure 2).
4. Primary data sources for an expert system are national data registers, records, cadastres and other data bases owned by state institutions.
5. Each thematic data module is unique: data from one module do not appear in other modules.
6. Each data module is harmonized with the others and prepared in a unique geographical coordinate system.
7. Surface waters are represented by:
 - a) STATE TOPOGRAPHIC HYDROGRAPHY (attributes from the national hydrographic data base GKB25).
 - b) Objects of hydrography are categorized into four categories: rivers, lakes, transitional waters, coastal water; the data base is named HYDROGRAPHY WFD; Each object in the hydrography gets system A WFD typology attributes (Globevnik, 2000).



Slika 2. Zasnova strukture podatkov ekspertnega informacijskega sistema za načrtovanja upravljanja z vodami: tematski podatkovni moduli so pripravljene kot agregati osnovnih podatkovnih virov ali kot rezultat modeliranja.

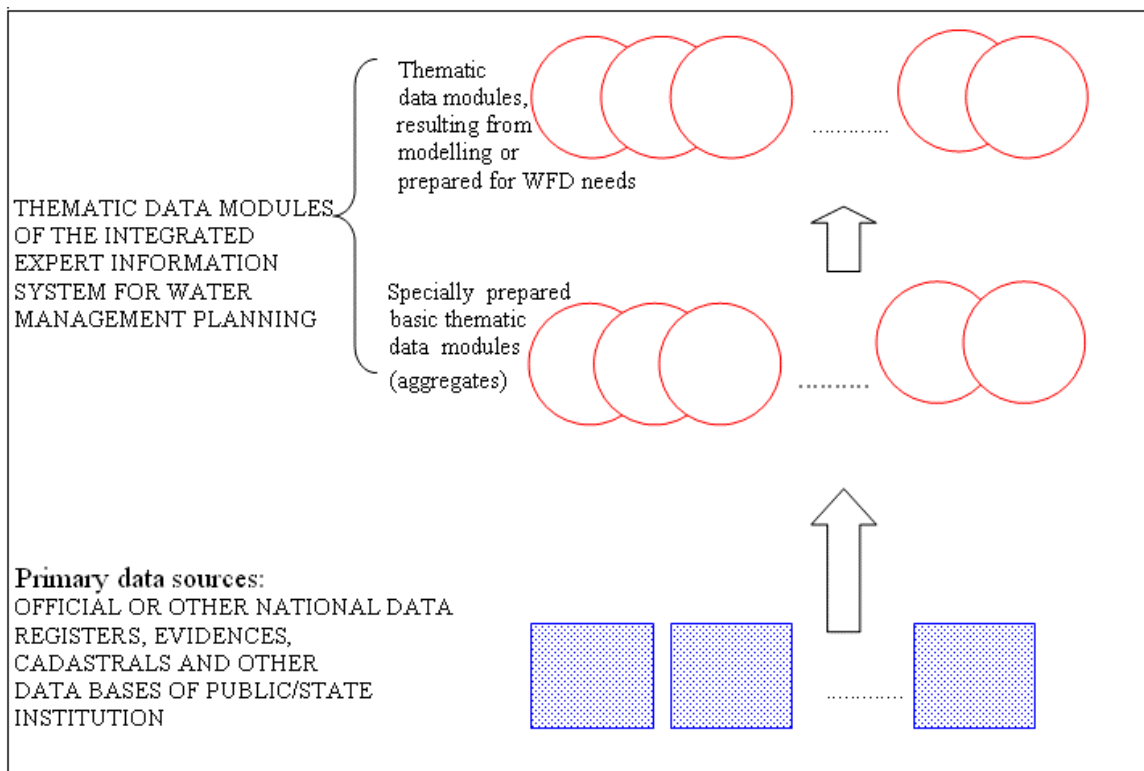


Figure 2. The concept of data structure of the expert information system for water management planning: thematic data modules are prepared as aggregates from primary data sources or as results from modelling.

Preglednica 2. Seznam osnovnih podatkovnih virov.

Kratka oznaka podatkovne baze	Državna inštitucija	Opis podatkovne baze: velja za ARSO Uradno ime podatkovne baze (velja za SURS, IVZ, GURS, MKGP)
ARSO – m.o.pod.v.	ARSO	MONITORING ONESNAŽENOSTI PODZEMNIH VODA
ARSO – m.o.povr.v.	ARSO	MONITORING ONESNAŽENOSTI POVRŠINSKIH VODA
ARSO – podzemne vode	ARSO	GEOREFERIRANI PODATKI O VODONOSNIKIH IN SMEREH TOKA PODZEMNE VODE
ARSO – c.st.j.sl.	ARSO	CENE STORITEV OBVEZNIH JAVNIH SLUŽB
ARSO – emisije	ARSO	EMISIJSKI MONITORING
ARSO – vod.knj.	ARSO	VODNA KNJIGA
ARSO – met.opaz	ARSO	METEOROLOŠKA OPAZOVANJA
ARSO – hidr.podz.v.	ARSO	HIDROLOŠKA OPAZOVANJA PODZEMNE VODE
ARSO – hidr.povr.v.	ARSO	HIDROLOŠKA OPAZOVANJA POVRŠINSKE VODE
ARSO – mokri	ARSO	MOKRIŠČA MEDWET 2000
ARSO – vodni viri	ARSO	ZAJETI VODNI VIRI IN VODOVARSTVENA OBMOČJA
MOP	MOP	NATURA 2000
NIB – morje	ARSO	FIZIKALNO KEMIJSKE IN BIOLOŠKE ANALIZE VTOKOV REK V MORJE IN MORJA
KME-20	SURS	POROČILO O KMETIJSKIH ZEMLJIŠČIH
KME-DEC/L	SURS	LETNO POROČILO O ŽIVINOREJI, POSEJANIH POVRŠINAH V JESENSKI SETVI
KME-71	SURS	LETNO POROČILO POSLOVNIH SUBJEKTOV S PODROČJA KMETIJSTVA
VOD N	SURS	POROČILO O NAMAKALNIH IN OSUŠEVALNIH SISTEMIH
VOD-1, VOD UVI	SURS	LETNO POROČILO O UPORABI VODE IN VARSTVU PRED ONESNAŽEVANJEM
VOD V	SURS	POROČILO O JAVNEM VODOVODU
VOD K	SURS	POROČILO O JAVNI KANALIZACIJI
IZV 71	IVZ	EVIDENCA PRESKRBE PREBIVALSTVA S PITNO VODO
IZV 72	IVZ	EVIDENCA HIGIENSKE USTREZNOSTI VODE
IZV 73	IVZ	REGISTER KOPALNIH VODA
GURS – hidro	GURS	GKB25 (HIDROGRAFIJA SLOVENIJE)
GURS – admin.b.	GURS	REGISTER PROSTORSKIH ENOT (MEJA DRŽAVE, MEJE OBČIN)
ZZR	MKGP	RIBIŠKI KATASTER
MKGP – nam	MKGP	REGISTER MELIORACIJ IN NAMAKALNIH SISTEMOV

ARSO: Agencija RS za okolje, NIB: Nacionalni inštitut za biologijo; SURS: Statistični urad RS, IVZ: Inštitut za varovanje zdravja; GURS: Geodetska uprava RS; ZZR: Zavod za ribištvo; MKGP: Ministrstvo za kmetijstvo, gozdarstvo in prehrano;

Table 2. List of primary data sources.

Data base short name	State body	Data base description
ARSO – m.o.pod.v.	ARSO	MONITORING OF GROUND WATER QUALITY
ARSO – m.o.povr.v.	ARSO	MONITORING OF SURFACE WATER QUALITY
ARSO – podzemne vode	ARSO	GEOREFERENCED DATA OF AQUIFERS AND GROUND WATER FLOW DIRECTIONS
ARSO – c.st.j.sl.	ARSO	PRICES OF PUBLIC SERVICES
ARSO – emisije	ARSO	EMISSION MONITORING
ARSO – vod.knj.	ARSO	REGISTER OF WATER RIGHTS (VODNA KNJIGA)
ARSO – met.opaz	ARSO	METEOROLOGIC MONITORING
ARSO – hidr.podz.v.	ARSO	HYDROLOGICAL MONITORING OF GROUNDWATER

ARSO – <i>hidr.povr.v.</i>	ARSO	HYDROLOGICAL MONITORING OF SURFACE WATER
ARSO – <i>mokri</i>	ARSO	WETLANDS (MEDWET 2000)
ARSO – <i>vodni viri</i>	ARSO	CAPTURED WATER SPRINGS AND PROTECTION ZONES FOR DRINKING WATER
MOP	MOP	NATURA 2000
NIB – <i>morje</i>	ARSO	PHYSICAL, CHEMICAL AND BIOLOGICAL MONITORING OF THE SEA AND RIVER INFLOWS TO THE SEA
KME-20	SURS	REPORTS ON AGRICULTURAL LAND
KME-DEC/L	SURS	ANNUAL REPORT ON LIVESTOCK, HARVESTED AREAS IN AUTUMN
KME-71	SURS	ANNUAL REPORT ON ENTERPRISES, COMPANIES AND OTHER ORGANISATIONS IN AGRICULTURE
VOD N	SURS	REPORT ON IRRIGATION AND DRAINAGE SYSTEMS
VOD-1, VOD UVI	SURS	ANNUAL REPORT ON WATER USE AND POLLUTION CONTROL
VOD V	SURS	REPORT ON PUBLIC WATER SUPPLY
VOD K	SURS	REPORT ON PUBLIC SEWERAGE SYSTEMS
IZV 71	IVZ	EVIDENCE OF DRINKING WATER SUPPLY
IZV 72	IVZ	EVIDENCE OF HYGIENE SUITABILITY OF DRINKING WATER
IZV 73	IVZ	BATHING WATER REGISTER
GURS – <i>hidro</i>	GURS	GKB25 (HYDROGRAPHY OF SLOVENIA)
GURS – <i>admin.b.</i>	GURS	REGISTER OF SPATIAL UNITS (STATE BORDER, COUNTIES BORDER)
ZZR	MKGP	FISH CADASTRE
MKGP– <i>mel</i>	MKGP	REGISTER OF AMELIORATED AND IRRIGATED AREAS

ARSO: Agencija RS za okolje, NIB: Nacionalni inštitut za biologijo; SURS: Statistični urad RS, IVZ: Inštitut za varovanje zdravja; GURS: Geodetska uprava RS; ZZR: Zavod za ribištvo; MKGP: Ministrstvo za kmetijstvo, gozdarstvo in prehrano

8. Najprej se pripravi podatkovne baze, ki jih določa 3. člen Vodne direktive (EC, 2003); attribute se določi po smernicah za izvajanje GISa v Vodni direktivi (EC, 2002). Nato se pripravi podatkovne baze, ki jih določa 5. člen Vodne direktive. Najvažnejši sta podatkovni bazi VODNIH TELES: baza površinskih vodnih teles in baza podzemnih vodnih teles.
9. Grafični objekti podatkovne baze površinskih vodnih teles se ujemajo z hidrografijo GKB25.
10. Objekti v vsaki podatkovni bazi so georeferirani v 2D-prostoru z Gauss Krügerjevimi koordinatami.
11. Osnovna geografska podatkovna baza je baza hidrografskih območij (Šraj in Brilly, 2000).
8. First those data bases are prepared that are defined by Article 3 of the Water Framework Directive (EC, 2003); attributes are defined by guidelines on GIS implementation in the Water Framework Directive (EC, 2002). Then data bases defined by Article 5 of the Water Framework Directive are prepared. The most important are data bases of WATER BODIES: surface water bodies data base and groundwater bodies data base.
9. Graphical objects of the surface water bodies data base are identical with hydrography GKB25.
10. Objects in each data base are georiented in the 2D surface with the Gauss-Krüger coordinate system.
11. The basic geographical data base is the hydrogeographical area data base (Šraj and Brilly, 2000).

3.2.3 OSNOVNI PODATKOVNI VIRI IN TEMATSKI PODATKOVNI MODULI SISTEMA

Preglednica 2 podaja osnovne podatkovne vire, ki se lahko uporabijo za pripravo tematskih podatkovnih modulov ekspertnega informacijskega sistema (preglednica 3). V sistem se vključi tudi podatkovne baze ali karte geologije, pedologije, reliefa, rabe tal in GKB25-H.

3.2.3 PRIMARY DATA SOURCES AND THEMATIC DATA MODULES OF THE SYSTEM

Table 2 shows primary source data bases, which could be used for preparation of data thematic modules (Figure 3). In the sistem data base or maps of geology, pedology, digital terrain model, land use and GKB25 are included.

Preglednica 3. Tematski moduli ekspertnega integralnega informacijskega sistema za načrtovanje upravljanja z vodami.

Nivo tematskih modulov	Ime tematskega modula
Tematski moduli, nujni za izvajanje 3. člena in 5. člena Vodne direktive	Vodna območja
	Povodja, porečja
	Ekoregije
	Glavne reke
	Tipologija površinskih voda
	Vodna telesa – površinske vode
	Vodonosniki
	Vodna telesa – podzemne vode
	Biološke pritiski
	Hidrološki pritiski
	Morfološki pritiski
	Kemični pritiski
	Vplivi
Ekonomsko pomembna vodna telesa	
Tematski moduli, dobljeni z agregacijo osnovnih podatkovnih virov ali modeliranjem	Ekološko stanje
	Biološko stanje
	Fizikalno-kemično stanje
	Hidrološko stanje
	Morfološko stanje
	Elektrarne na vodni pogon
	Vodovarstvene cone
	Viri oskrbe prebivalcev z vodo
	Vodni viri za oskrbo industrije in druge proizvodnje
	Vodovodni sistemi
	Vodne akumulacije
	Kanalizacijski sistemi in čistilne naprave
	Območja melioracij in namakanja
	Ribogojnice
	Ribištvo
	Rekreacija na vodi
Zaščitena območja narave	
Občutljiva območja	

	Natura 2000
	Območja erozije in plazov
	Poplavne površine
	Hidrografija WFD – reke (> 10 km ²)
	Hidrografija WFD – jezera (> 0,5 ha)
	Meteorološki monitoring
	Monitoring kakovosti voda
	Monitoring količin voda
	Hidrografska območja
Osnovni podatkovni moduli	Prostorske enote – občine, naselja
	Geologija, hidrogeologija
	Pedologija
	Relief in plastnice
	Raba tal
	GKB25-hidrografija

Table 3. *Thematic data modules of the integral information system for water management.*

Level of the thematic modules	Name of the thematic data modules
Thematic data modules for the implementation of Articles 3 and 5 of the Water Framework Directive	Water districts
	Catchment
	Ecoregions
	Main rivers
	Typology of surface waters
	Surface water bodies
	Aquifers
	Ground water bodies
	Biological pressures
	Hydrological pressures
	Morphological pressures
	Chemical pressures
	Impacts
	Economically significant water bodies
Thematic data modules prepared as with aggregation of primary data sources or with modeling	Ecological state
	Biological state
	Chemical state
	Hydrological state
	Morphological state
	Hydroelectric power plants
	Drinking water protection zones
	Drinking water supply sources
	Industrial and other production water supply source
	Water supply system
	Water reservoirs
	Sewerage system and waste water treatment plants
	Ameliorated areas and irrigation
	Fish farms
Fishing	

	Recreation on water
	Nature protection areas
	Sensitive areas
	Natura 2000 – water
	Erosion and sliding areas
	Flood areas
	hydrography: WFD – rivers (> 10 km ²)
	hydrography: WFD – lakes (> 0,5 ha)
	Meteorological monitoring
	Water quality monitoring
	Water quantities monitoring
Basic thematic data modules	Spatial units – counties, settlements
	Geology, hydrogeology
	Pedology
	Relief and above sea contour lines
	Land use
	GKB25-hydrography
	Hydrographic areas

4. RAZPRAVA

Ideja, da podatke v prototipu združujemo po tematskih informacijskih slojih DPSIR, se je izkazala kot dobra. Dosegli smo, da se zapisi podatkov ne ponavljajo v več datotekah. S tem se močno zmanjša spominska velikost sistema. Zaradi te zasnove imajo sloji sicer različno veliko število podatkov. Nekateri na primer vsebujejo le osnovno in lahko tudi zelo enostavno karto (nekaj poligonov ali linij), medtem ko so drugi sloji kompleksni (reke, vodovarstvena območja ...). Topološke relacije med preglednicami in prostorskimi podatki, ki so osnova za GIS-analizo, tako niso mogle biti vzpostavljene za vse tematske sloje, temveč le za največje. V tematskih slojih, kjer prostorski objekti nimajo veliko atributivnih podatkov, se te lastnosti prikažejo kot DWG-sloji (layerji slike). V teh primerih ni treba vzpostaviti relacijskih podatkovnih baz in njihovih povezav, temveč le topologijo prostorskih objektov.

Prototip je pokazal, da izbrana organizacija podatkov nudi enostavno možnost dodajanja novih tematskih modulov brez sprememb starih. Povečevanje sistema je odvisno od razpoložljivosti novih podatkov ali potreb v prihodnje.

Veliko podatkov ni bilo vključenih v

4. DISCUSSION

The idea to aggregate data in the prototype to DPSIR thematic information layers has proven as a good one. We have prevented the duplication of data records in several files. The memory capacity is thus considerably reduced. Due to such design, the volume of data in the layers differs. Some layers may contain only a basic and possibly a were simple map (some polygons and lines ...), while others are more complex (rivers, water protection areas ...). Thus, topological relations between the tables and spatial data, which are the basis of the GIS analysis, could not be set up for all thematic layers, but only for the bulkiest ones. In the thematic layers, where there are not many attribute data assigned to the spatial objects, there features are shown as DWG layers (layers of images). In such cases it is not necessary to set up relational data bases and their connections, but only the topology of spatial objects.

The prototype has shown that the chosen organization of data offers a simple way of adding new thematic modules, leaving the old ones unchanged. The increase of the system depends on the availability of new data and future needs.

Many data were not included in the prototype, since they were not harmonized, georiented

prototip, ker niso usklajeni, georeferirani ali geokodirani. Za primer navajamo tri državne podatkovne baze o oskrbi z vodo (Statistični urad RS, Agencija RS za okolje, Inštitut za varovanje zdravja), ki za iste sisteme zbirajo podatke po drugačnih metodoloških izhodiščih. Za te sisteme tudi niso določeni enotni identifikatorji, da bi se podatke enostavno združilo.

S podatki, ki so vključeni v prototip, lahko že izvajamo različne analize (recimo izračunamo gostoto poselitve in rabo tal na hidrografskih območjih IV. ravni), količino vode in vsebnost kisika in hranilnih snovi v vodi na izbranih lokacijah, ali pa analiziramo pokritost izbranih območij z javnimi vodovodnimi sistemi in kanalizacijo.

V Sloveniji imamo skoraj 30 osnovnih podatkovnih virov vezanih na vodo, iz katerih lahko črpamo podatke za naš sistem. Pregled potreb po podatkih in pripravi novih informacij za potrebe izvajanja Vodne direktive je pokazal, da moramo izdelati preko 40 tematsko zaključenih podatkovnih modulov. Nekateri od teh se bodo verjetno delili naprej na nove, neodvisne podatkovne module.

5. ZAKLJUČKI

Razvit je prototip ekspertnega informacijskega sistema za načrtovanje upravljanja voda v Sloveniji. V njem so zbrane informacije o vodah, njihovi zaščiti in pritiskih nanje. Podatki so bili pred vnosom verificirani in logično integrirani. Prototip je integriran v medmrežni sistem, s čimer je omogočen javni dostop do informacij. Vsak informacijski tematski sloj je predstavljen s slikovno podobo, tako da lahko uporabnik podatke hitro najde.

Prototip vsebuje tudi osnovne informacije o prostoru, s katerimi izdelujemo analize ali prikaze. Izračunamo lahko gostoto prebivalstva, rabo tal po povodjih ali porečjih, vodne količine in kemično stanje (kisik in koncentracija hranil) vode ali analiziramo vodovarstvene režime po občinah ali upravnih enotah.

Ker se je zasnova informacijskega sistema

or geocoded. Three state data bases on water supply are provided as example (Statistični urad RS, Agencija RS za okolje, Inštitut za varovanje zdravja), which collect data according to different methodological approaches for the same systems. There are no unified identifiers set for these system, which would enable a simple unification of the data.

The results included into the prototype enable us to perform different analyses (for example the calculation of population density and land use in hydrographical areas of level IV), water quantity and oxygen and nutrient content in the water at the chosen locations, or analysis of coverage of chosen areas with public water supply systems and sewerage systems.

In Slovenia there are almost 30 basic data base sources related to waters, which are the basis for the data used in our system. A review of data requirements and preparation of new information for the needs of implementing the Water Framework Directive has shown the need for over 40 thematical data modules. Some of these will probably be further divided into new, independent data modules.

5. CONCLUSIONS

A prototype of an expert information system for water management planning in Slovenia has been developed. It consists of water related data, data on water protection and pressures. Prior to data entering, the data were verified and logically integrated. The prototype was integrated into a network system, which enabled public access to data. Each information thematic layer was represented by an image, so that the user can find data as quickly as possible.

The prototype also contains the basic data on space, which help us prepare analyses and presentations. One can calculate population density, land use in catchments and river basins, water quantity and chemical status (oxygen and nutrient concentration) of water or one may analyse water protection regimes in municipalities and administrative units.

Since the design of the information system has proven successful, new data thematic

izkazala za uspešno, se pripravljajo podatkovni tematski moduli za kompleksnejši informacijski sistem za načrtovanje upravljanja z vodami. Ker se bo informacijski sistem uporabljal za analize stanja in vplivov različnih pritiskov na vodo, za oceno uspešnosti izvajanja predlaganih ukrepov in pripravo tekstovnih in slikovnih gradiv za načrte upravljanja z vodami, smo ga označili kot 'ekspertni informacijski sistem'.

modules for a more complex information system are being prepared that will facilitate water management. The information system has been named as an 'expert information system', since it will be used for analysing the state and influence of different pressures on waters, for estimating the success of implementation of proposed measures and preparation of text and image material for water management planning.

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