

XXXVIII IAH Congress

Groundwater Quality Sustainability
Krakow, 12–17 September 2010

Extended Abstracts

Editors:
Andrzej Zuber
Jarosław Kania
Ewa Kmiecik



University
of Silesia
Press 2010



abstract id: **438**

topic: **1**
Groundwater quality sustainability

1.10
Decision support tools for sustainable groundwater management

title: **Potential of semantic wiki tools to organize interdisciplinary IWRM approaches**

author(s): **David Riepl**
Karlsruhe Institute of Technology, Germany, riepl@kit.edu

Leif Wolf
Karlsruhe Institute of Technology, Germany, wolf@kit.edu

Heinz Hötzl
Karlsruhe Institute of Technology, Germany, hötzl@kit.edu

keywords: IWRM, decision support, knowledge management, Lower Jordan River Catchment

INTRODUCTION

Following the principles of Integrated Water Resources Management (IWRM), the impact of a planning scenario has to be collectively evaluated from various viewpoints, corresponding to the knowledge of experts in different domains as well as to the interests of various stakeholders. Thus, the development of a comprehensive and interdisciplinary water resources knowledge base is perceived as fundamental to integrated water resources assessment and consequent decision making (GWP, 2000). It is also recognised that contemporary knowledge management techniques can contribute to improving the performance and effectiveness of both capacity development (FAO & IPTRID, 2005) and knowledge sharing (Giupponi & Sgobbi, 2007) in the water sector, provided that there is a basic capacity in place to coordinate this approach. To handle this necessity, most IWRM projects carried out during the last years already had knowledge sharing initiatives on their agenda. The requirement for such a knowledge framework is tackled in current IWRM approaches in several manners: (i) Applied projects and case studies usually share multi-thematic databases and Information Systems to enable data access, transfer and comparability between their interdisciplinary modelling environments. (ii) Joint projects implement internet platforms for building and distributing thematic bibliographies as information portals on IWRM related topics (e.g. CAWaterInfo: <http://www.cawater-info.net>), or (iii) focus on supporting Capacity Building Networks in the IWRM environment (e.g.:

- CAP-NET: <http://www.cap-net.org>;
- GWPToolbox: <http://www.gwptoolbox.org>).

However, the direct support of IWRM decision processes in the planning practice through adequate knowledge management strategies is still lacking satisfactory consideration in state of the art approaches on IWRM-Decision-Support-Systems (DSS). To address this necessity it requires a knowledge management framework that enables experts, planners and decision makers to conduct specific queries for available and relevant information during the decision process, directly address critical knowledge gaps, feedback new information into the structure and continually evolve the knowledge base. In the domain of participatory knowledge management, Wiki-systems are considered as young and promising approach for collaborative and flexible knowledge-transfer (Wagner, 2004), which have become well-established in short term and are already successfully implemented in many corporate environments (Hof, 2004; Swisher, 2004). Furthermore, the recent enhancement of the Wiki-technology through semantic concepts (Schaffert et al., 2008), enables additional functionality for the efficient use of Wikis as structured knowledge management tools (Oren et al., 2006).

The aim of this research is to explore the actual knowledge requirements of the IWRM decision process and analyse the potential of the semantic wiki technology as flexible knowledge management tool in a IWRM-DSS-framework. To support the theoretic findings, the presented approach is implemented as a prototype for a case study in Jordanian Wadi, a subcatchment of the Jordan Valley.

POTENTIAL OF SEMANTIC WIKIS TO ORGANIZE IWRM KNOWLEDGE

Wikis enable online interaction and collaboration in the form of web pages which can be edited and structured with a simple markup language by anyone who has appropriate access and a

internet browser. Lately, wikis are also becoming popular for personal and organizational knowledge management as well, as they enable communication and collaboration, in opposition to only knowledge storage, common of many traditional knowledge management systems (Fuchs-Kittowski & Kohler, 2005). The success of wiki tools for collaborative information collection can also be observed by success and the relatively high quality of the Wikipedia encyclopedia (Giles, 2005).

Semantic Wikis combine properties of wikis (ease of use, powerful collaboration emphasis, strong linking) with Semantic Web technologies (semantic structuring of knowledge, linking with background knowledge models, logic reasoning). This results in access to the inbuilt structure of a wiki for logic reasoning, by annotating existing links with attributes that describe their meaning (e.g., a link from Karlsruhe to Germany could be annotated with *“located in”*) (Schaffert et al., 2008). This feature can be used for enhanced navigation and semantic queries to contextual information.

There are different Semantic Wikis software recently under development which feature some similar and some unlike functionalities. For our study we chose the “Semantic MediaWiki” (SMW) project (Krötzsch et al., 2007), which originated from the AIFB Institute of the University of Karlsruhe as an open source extension to the well known MediaWiki implementation, but at this time has attracted a large developer and user community (<http://www.semantic-mediawiki.org>).

The SMW-framework has potential to support several critical knowledge management aspects for the implementation in an IWRM-DSS context:

- Strong support for collaborative work in a community of different domains.
- Possibility to gather, store and edit information in many types of rich content (e.g. text, data values, references, images, maps, files, videos ...).
- Possibility to establish and evolve the semantic structure of the IWRM knowledge elements flexibly, introduce new knowledge elements or change the properties of existing ones).
- Possibility to establish meaningful links between the knowledge elements.
- Enable free browsing but also structured queries for specific knowledge elements.

On the downside, some important shortcomings of the basic functionality for ready use in a IWRM-DSS environment have to be mentioned:

- Presentation capabilities do not support dynamic graphical representation of information elements, e.g. of a water balance scheme that dynamically represents its elements according to their data values, or the dynamic representation of the cause effect network for graphical browsing.
- Support for temporal and spatial variability of properties, e.g. in different scenario context, has to be represented by a workaround with multi-valued properties.
- Some missing semantic functionality, e.g. inheritance of properties from category to sub-category, which would enhance better ontology support.

However, due to the very generic building blocks of the SMW-software it seems feasible to implement some of the missing functionalities by developing supplementary extensions.

Further open questions are related to the prospective of integrating the Wiki structure with other IWRM-DSS elements (relational and spatial databases, system models and multi-criteria decision tools).

CASE STUDY

Study Area

For an extensive evaluation of the applicability of the SMW-software in the IWRM context we apply a prototype of the SMART Knowledge Management System for a Jordanian Wadi within the Balqa Governorate. The Wadi Shueib (Fig. 1), an eastern side wadi of the Jordan Valley near the capital Amman, is characterized by a steep relief with elevations ranging from -200 m bsl in the southwest up to 1240 m asl in the northeast. The climate in the wadi is semi-arid and classified within the Mediterranean climate zone with large seasonal and daily temperature variations (Bender, 1968). Precipitation is directly related to the terrain elevation, resulting in variations of annual rainfall from over 600 mm at the town of Salt in the northern part to less than 200 mm at the southern catchment outlet, with a maximum in the Winter months (Taa'ny, 1992). Potential Evaporation Rates in the area range from 1mm/d (winter months in the higher altitudes) to 8 mm/d (summer months in the southern part of the wadi).

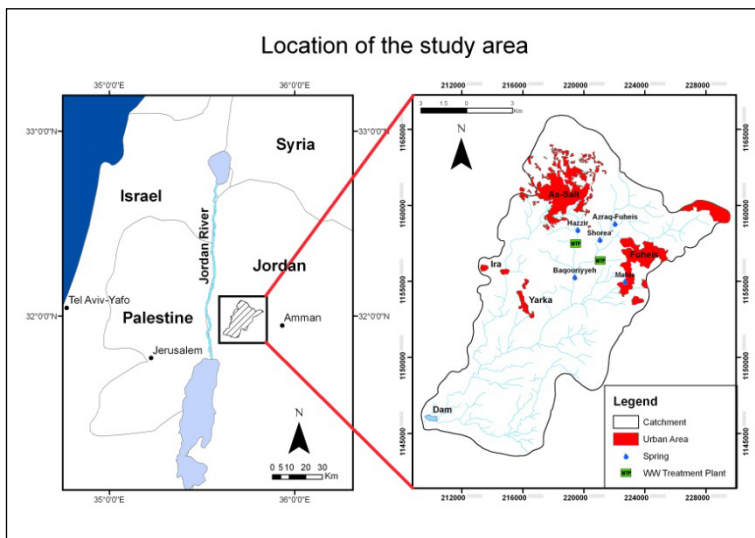


Figure 1. Overview over the Wadi Shueib catchment area.

The area comprises 5 larger municipalities (Salt, Fuheis, Mahis, Yarka, Ira) and several small hamlets with a total population of approximately 109472 people according to the last demographic census (DOS, 2004). The population density, as well as most agricultural activity is concentrated in the higher altitudes in the northern part of the Wadi. The dense drainage network of the escarpment discharges the periodic flush floods of the rainy season to the Jordan Valley floor. The baseflow in the main channel is perennial and comprises the discharge from several springs, the outflow of the two sewage treatment plants in Salt and Fuheis as well as some untreated sewage from the smaller municipalities (Ira and Yarka).

In 1968 a dam was constructed in Wadi Shueib at the outlet in order to catch up the flows, but falls dry during the summer months. The main water source in the Shueib area is ground water (pumped wells and springs) from the karst-aquifers.

The urgent issues for the water management in the Wadi Shueib are related to the municipal water supply, being the main user in this area. Due to microbiological and nitrate contamination, the available freshwater resources from the spring discharge are not used to their potential extent. The high rate of physical losses in the water infrastructure increases the supply need to cover the municipal demand by over 40%. To cover the municipal demand, water is imported at a rate of 2.2 MCM/a from the water supply of Amman. With regard to the high population growth in Jordan and the increasing living standards, this situation is likely to aggravate in the near future. The sewer coverage is only about 65%. Consequently, contamination of groundwater is widespread and in many cases contributes to the high coliform levels in spring waters mentioned above.

Water System Assessment in Wadi Shueib

The current state of the water system in the Wadi Shueib Area, its interrelation with other sectors and the existing deficits were compiled in a comprehensive review of available data from various related sector actors (MWI, WAJ, JVA), a broad range of literature sources and within interdisciplinary discussions with partners from governmental agencies, research facilities and development cooperation institutions. The findings resulted in a holistic water balance scheme, a problem analysis of causal relationships and the elaboration of potential response scenarios after the DPSIR (Driver, Pressure, State, Impact, Response) framework (OECD, 1993).

Implementation of the Case Study in the Knowledge Management Framework

However, as a typical matter of comprehensive information gathering processes in the IWRM domain, the assemblage left several data and information gaps, uncertainties as well as some inconsistencies, since

- some Data/Information were unknown or
- not available for review or
- were ambiguous as contributed from different sectors,
- investigations in the consulted data and literature sources originate from a broad time period (1990-2006), and it has to be assumed that the water system in the Wadi Shueib area has already been significantly changed during this period.

Thus, to continually improve the quality and to best reflect the actual state, it seems necessary that the available information is constantly reviewed by practitioners and researchers involved in the water sector of Wadi Shueib. Furthermore the decision and planning process of the possible response scenarios needs continuous input from the modelling and domain experts in order to close critical knowledge gaps. Therefore the comprehensive results of the water system assessment are in the process of being transferred into the knowledge structure of the SMART Knowledge Base with the Semantic Wiki software to be opened for the collaborative work process between the project partners.

CONCLUSIONS

This study has analysed the potential contribution made by a particular type of technology, a semantic wiki tool, to the development of a knowledge management framework for IWRM approaches. The assessment showed the theoretic suitability of the Semantic MediaWiki software to support several critical knowledge management aspects, especially the strong collaborative functionality and the high flexibility of the generic semantic structure. Furthermore, since based on the popular MediaWiki, the system embraces a large user and developer community which results in fast development (quarterly update releases and already over 1300 extensions available for the MediaWiki project: <http://www.mediawiki.org>). Development needs could be mainly identified in respect to presentation and visualization capabilities in order to enable dynamic graphics, and in respect to full semantic reasoning support. Further research is also necessary focussing on the integration possibilities of the Semantic Wiki approach within the larger IWRM-DSS framework.

The information gathered for the IWRM challenges in the Wadi Shueib catchment builds a solid use case for testing the implementation of the IWRM knowledge management prototype, which is the next step in the process of this study.

Probably the most advantageous characteristic of a Semantic Wiki approach in the IWRM-DSS context is the collaborative evolving nature of its structure and content, which resembles a constant peer review process where the target audience keeps on adding to the knowledge base that has been created.

REFERENCES

- Bender F., 1968: *Geologie von Jordanien.(Geology of Jordan.)*, 230 p., Berlin (Bornträger).
- DOS (The Hashemite Kingdom of Jordan, Department of Statistic), 2004: *Final Results of the Population and Housing Census*. <http://www.dos.gov.jo/>
- FAO & IPTRID, 2005: *Workshop Proceedings on Design and Implementation of Capacity Development Strategies - Final Report*. In: Series title: International Programme for Technology and Research in Irrigation 2005, 143 p.
- Fuchs-Kittowski F., Köhler A., 2005: *Wiki communities in the context of work processes*. WikiSym '05, October 16-18, San Diego, CA, U.S.A.
- Giles, J., 2005: *Internet encyclopaedias go head to head*. Nature 438, pp. 900-901 (15 December 2005).
- Giupponi C., Sgobbi A., 2007: *Models and decision support systems for participatory decision making in integrated water resource management*. In: Koundouri P. (ed.): *Coping with water deficiency. From research to policy making*, Ed. Springer, pp. 165-186.
- Global Water Partnership (GWP), 2000: *Integrated Water Resources Management – (TAC background paper no. 4)*. Stockholm, Sweden. online at: <http://www.gwpforum.org/gwp/library/Tacno4.pdf>
- Hof R.D., 2004: *Something Wiki This Way Comes: They're Web Sites Anyone Can Edit -- and They Could Transform Corporate America*. Business Week, June 7, 2004, 128 p.

Holsapple C., 1995: *Knowledge Management in Decision Making and Decision Support*. Knowledge Policy, 8(1), pp. 5-22.

Kröttsch M., Vrandeic D., Völkel M., Haller H., Studer R., 2007: *Semantic Wikipedia*. Journal of Web Semantics 5/2007, pp. 251-261. Elsevier.

Malczewski, J., 1999: *GIS and Multicriteria Decision Analysis*. Wiley, New York, 392 p.

OECD, 1993: *OECD core set of indicators for environmental performance reviews*. OECD Environmental Directorate Monographs No.83.

Oren E., Völkel M., Breslin J.G., Decker S., 2006: *Semantic Wikis for Personal Knowledge Management*. Database and Expert Systems Applications: 4080, pp. 509-518.

Schaffert S., Baumeister J., Bry F., and Kiesel M., 2008: *Semantic Wikis*. IEEE Software, 25 (4), pp. 8-11.

Simon H.A., 1960: *The New Science of Management Decision*. New York: Harper and Row.

Sprague R. H., Carlson E. D., 1982: *Building Effective Decision Support Systems*. Prentice Hall, Inc., Englewood Cliffs.

Swisher K. 2004: *Boomtown: "Wiki" May Alter How Employees Work Together*. Wall Street Journal, July 29, 2004, p. B. 1.

Ta'any R. A., 1992: *Hydrological and Hydrochemical Study of Major Springs in the Wadi Shueib Catchment*. Master Thesis Yarmouk University, Irbid (unpublished), 300 p.

Wagner C., 2004: *Wiki: A Technology for Conversational Knowledge Management and Group Collaboration*. Communications of the Association for Information Systems, 13, pp. 265-289.

WEB RESOURCES

CAWaterInfo: <http://www.cawater-info.net> – accessed May 2009

CAP-NET: <http://www.cap-net.org> – accessed May 2009

GWPTtoolbox: <http://www.gwpttoolbox.org> – accessed May 2009

MediaWiki: <http://www.mediawiki.org> – accessed May 2009

Semantic MediaWiki: <http://semantic-mediawiki.org> – accessed May 2009



International Association of Hydrogeologists



AGH University of Science and Technology

2-vol. set + CD
ISSN 0208-6336
ISBN 978-83-226-1979-0